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ABSTRACT

This volume comprises the papers presented at the 1994 conference of the Pacific Telecommunications Council. This gathering, which focused on the theme, "Forging New Links: Focus on Developing Economies," brought together more than 1,100 participants from over 40 countries. The 146 papers are organized chronologically, according to date of presentation. Topics covered in the papers include accounting rates/tariffs, alliances, area networks, asynchronous transfer mode, broadband applications, broadcasting policy, broadcasting technology, cable television, cellular applications, competition/privatization, convergence, data communications, development applications/technologies, multinational/international development policies, national development policies, technology transfer, disaster communications, distance education, foreign investment, INTELSAT, Internet, multimedia, network management, network technologies, personal communications, policy issues, regulatory issues, rural and remote applications, satellite applications, competitive systems satellites, satellite technologies, security issues, socio-cultural issues, standards, submarine cables, telework/telecommuting, trade issues, training/human resources development, videoconferencing/teleconferencing, videotext, virtual networks, and wireless local loop. Subject, country, and author indexes are included. Many of the papers contain references.

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Pacific Telecommunications Council Sixteenth Annual Conference

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Edited by
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January 16–20, 1994
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Erratum

We would like to call your attention to a page-numbering error in the PTC'94 Proceedings:

Paper Title: ***Development of the Telecommunications Sector in Less Developed Countries: Investment, Regulatory and Personnel Challenges***

Author: Llewellyn "Lew" Toulmin ,Ph. D., Senior Associate, Booz, Allen & Hamilton, Inc., USA

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THE PACIFIC TELECOMMUNICATIONS COUNCIL

PTC'94 is organized by the Pacific Telecommunications Council, an international non-governmental, non-profit organization. The council is regional in nature, embracing members from all the countries that play a role in the development of Pacific telecommunications. Its 445 members from industry, academia and government are dedicated to promoting the understanding and beneficial use of telecommunications throughout the entire Pacific Hemisphere--North, Central, and South America, East, South and Southeast Asia, Australia, New Zealand, Melanesia, Micronesia and Polynesia.

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FOREWORD

Ten years ago, the Independent International Commission for World Wide Telecommunications Development, itself a product of the 1982 International Telecommunication Union Plenipotentiary meeting, held a series of meetings in cities around the developing world. The "Maitland Commission", named after the ICWWTD Chairman, Sir Donald Maitland, reported its findings in a landmark report entitled The Missing Link. The report provided a comprehensive, unprecedented review and analysis of policies on communications development and a study of how to better stimulate the development of telecommunications infrastructures. Some of its findings were so dramatic and oft-cited that they have almost become telecoms "cliches", e.g., there are more telephones in Tokyo than in all Africa.

From the perspective of 1994, the tenth anniversary of The Missing Link, it is difficult to appreciate the enormity of the task confronted by the Commissioners. Developing countries did not axiomatically consider telecommunications to be central to development. Developed countries, bilateral foreign aid programs, and multilateral development agencies all exhibited a great deal of indifference to telecoms. The telecoms industry itself contributed to the growing disparity between richer and poorer nations by focusing unduly on expensive state-of-the-art technology. What is now an immense market for low cost, simple, and "thin route" solutions was largely undiscovered.

This volume of Proceedings comprises the papers presented at the Sixteenth Annual Pacific Telecommunications Conference (PTC'94), held in Honolulu on 16-20 January 1994. This gathering brought together over 1,100 participants from over 40 countries. The Conference theme was "Forging New Links: Focus on Developing Economies". Ten years after the Missing Link, PTC'94 analyzed and assessed the state of telecoms development today, and provided a look at future directions. Most of the key personalities in international telecommunications today are to be found in these pages.

The book is dedicated to Sir Donald Maitland and the others who comprised the Maitland Commission, many of whom were present at PTC'94. The Commission's work led directly to what is now a universal recognition of the importance of telecommunications to meaningful development. Many developing countries have seen telecoms progress well beyond the most optimistic hopes of the Commission. Even more heartening is the method by which this success was achieved, for development has been largely a private sector-focused, developing country-led endeavour.

But massive disparities still exist, and much of the world's population remains excluded from the global network. The state of the world's telecommunications continues to bring to mind the T.S. Eliot quotation, "Success is relative: It is what we can make from the mess we have made of things".

While many of the sessions at PTC'94 focused on development issues, a glance at the table of contents or subject index will reveal the breadth of coverage for which PTC is now famous. PTC's Annual Conference is the region's premier venue for those interested in the world of international communications. The Conference is now a vital gauge to assess what the industry views as important. This year saw a dramatic increase in the number of papers on broadcasting and convergence issues, a resurgence of interest in VSATs, an unprecedented focus on Latin American telecoms, and the continuing frenetic activity amongst the various satellite operators in the region.

Published in a separate volume, the PTC'94 Session Summaries provide a useful digest to every paper presented at the Conference, and a slim volume of PTC'94 Plenary Presentations is also printed separately.

These Proceedings follow the general course of PTC'94, ranging from general Discussion Papers offering a broad overview of communications issues to a collection of conference papers unparalleled in their scope and depth. The Pacific Telecommunications Council has, for the past sixteen years, served as the leading international non-profit membership telecommunications organization in the Pacific hemisphere. The Conference Proceedings date back to 1979 and provide a uniquely valuable archive for the communications world. PTC also publishes the quarterly PTR - Pacific Telecommunications Review, which provides a continuing forum for leading analysis and lively commentary on telecoms issues.

This book is divided by Conference days, beginning with a comprehensive table of contents and an index. The index permits you to look up papers by subject, country of focus, or author. It appears immediately following the table of contents and cites papers by paper number rather than page number. Once you have found the paper number, flip back to the table of contents to find the page number. We would like to say this two-step process is part of a masterful strategy to sharpen the intelligence and skill of the reader. In fact, it is merely a necessary consequence of the tight production schedule that enables us to get the Proceedings into your hands in time for the Conference.

James Savage
Dan Wedemeyer
Honolulu, 1994

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SUNDAY, January 16, 1994

Discussion Groups

NOTES

DATABASES IN JAPAN:
BUSINESS, GOVERNMENT, AND OVERSEAS ACCESS FROM NORTH AMERICA

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This essay reviews issues of technology, access, and availability of Japanese databases and explains opportunities for access from overseas. Unfortunately, Japan's resources are inadequately used because of lack of technical knowledge, perceptions about access, or failings of availability. Efforts in Japan and the United States seek to overcome these shortcomings.

PREFACE

Databases in Japan are a recent development. In 1979, the industry association (DINA) started with 19 firms and in 1982, MITI began efforts to publish a database whitepaper at the Database Promotion Center (DPC).[1] More recently in industry data from DPC, the 1991 market size was 216 billion yen and the number of databases tripled by growing from 296 databases in 1986 to 892 databases by 1992. Categories of information sources are divided among business (39.5%), science and technology (29.6%), social sciences (3.5%), and a general category including newspapers (26.8%). But rather than industry alone, government involvement of DPC and other agencies has led foreign observers to ask about coordinated Japanese national strategies in information technologies. A widespread perception exists that Japan lags in this industry and related telecommunications.[2]

Several organizations are urging greater attention to these database resources. In February 1992, the initial meeting of the U.S. National Coordinating Committee (NCC) on Japanese Library Resources assigned a task force to report on databases. The NCC reviewed the reports produced after the November 1991 conference of a national planning team at the Hoover Institution at Stanford University. An NCC task force report resulted from comments and suggestions made by members of the Stanford and NCC meetings as well as interviews in Tokyo with various Japanese experts.[3] The Association of Research Libraries has supported these efforts and constituted a joint ARL/NCC committee to pursue pilot studies. This essay summarizes such efforts to emphasize that technology, access and availability are areas requiring attention to improve the use of Japan-related databases by libraries in North America.

Japanese databases are increasingly available for domestic and international use. By database technologies, two main types are commonly defined: on-line services using telecommunications lines and off-line sources using CD-ROM or magnetic tapes. To identify themes common to such related media, such technology is discussed to chart the expanding technical options for use of information from Japan available for end users and specialists.

For purposes of this paper, the discussion and appendix define technological terms and distinguish among issues of technology, access, and availability. Access refers to overcoming the barriers that limit use of existing resources and technology. Availability will refer to the specific priorities and examples of the use of Japanese databases in the United States. The paper also attaches a brief glossary of the acronyms and terms related to these issues.

Three priorities emerge for foreign users in North America. First, pilot projects and sharing of information are needed to assure common standards, detailed planning, and pooling of technical skill. Second, these projects will likely focus on access to resources available through Internet and alternative gateways to Japan and its databases as well as inexpensive sources of off-line CD-ROM sources. Third, on-going coordination among leading organizations is seeking to train information specialists, librarians and researchers with details related to databases in Japan.

The National Coordinating Committee (NCC) on Japanese Library Resources assigned a task force to report on databases. The NCC reviewed the reports produced after the November 1991 conference of a national planning team at the Hoover Institution at Stanford University. As a result in February 1992 at its initial meeting, the NCC constituted several new task forces to continue such efforts and the author co-chaired the task force. This report benefits from comments and suggestions made by members of the Stanford and NCC meetings as well as interviews in Tokyo with various Japanese experts. This paper recognizes that technology, access and availability are areas requiring attention to improve the use of Japan-related databases by libraries in North America.

1. Themes: Technology, Access, Availability

Several themes emerged from earlier meetings about Japanese databases. By database technologies, two main types are commonly defined: on-line services using telecommunications lines and off-line sources using CD-ROM or magnetic tapes. To identify themes common to such related media, technology is introduced below to chart the expanding technical options for use of information from Japan available for libraries and scholars. For purposes of the NCC task force, the discussion and appendix defined technological terms and sought to distinguish among issues of technology, access, and availability. Access refers to overcoming the barriers that limit use of existing resources and technology. Availability will refer to the specific priorities and examples of the use of Japanese databases in the United States. The NCC report also use a brief glossary of the acronyms and terms related to its task force that are attached to this paper.

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This paper reviews issues of technology, access, and availability of Japanese databases and finds growing opportunities for use by end-users and researchers in the United States. Unfortunately, resources are inadequately used due to lack of technical knowledge, perceptions about access, or failings of availability.

The paper identifies the following three priorities. First, pilot projects and sharing of information are needed to assure common standards, detailed planning, and pooling of technical skill. Second, projects are likely to focus on access to resources available through the Internet and alternative gateways to Japan and its databases as well as inexpensive sources of off-line CD-ROM sources. Third, on-going coordination within leading organizations will train librarians and give researchers timely information related to databases in Japan.

2. State-of-the-Art in Japan

A. Technology with Possibilities and Required Competence

A review of Japanese technology finds a growing gap between new possibilities and current competence in using databases. Rather than a criticism of existing practice, this observation reflects the pace of change in Japan due to the advances of microelectronics, corporate research and development, and the marketing of improved forms of information transfer. Neither librarians nor individual scholars can hope to maintain an equal pace with all the technological innovations. This task force does encourage an informed review of the state of the art in Japan to make better use of established technologies.

i. Databases

Databases in Japan began fairly recently. In 1979, the industry association (DINA) started with 19 firms and in 1982, MITI began efforts to publish a database whitepaper at the Database Promotion Center (DPC).[4] More recently in industry data from DPC, the 1991 market size was 216 billion yen and the number of databases tripled by growing from 296 databases in 1986 to 892 databases by 1992. Categories of databases are divided among business (39.5%), science and technology (29.6%), social sciences (3.5%), and a general category including newspapers (26.8%). Rather than industry alone, government involvement of DPC and other agencies has led foreign observers to ask about Japanese national strategies in information technologies.

a. Primarily Business

Business use of databases is the key factor in the expansion and structure of the Japanese market. A critical difference from the United States is that demand from educational institutions is relatively insignificant in the market for Japanese databases. Indeed, many Japanese universities are only beginning to establish local area networks and to link these schools with various academic networks. Rather than university or educational institutions, private companies set the pace, prices and means for access to Japanese databases.

b. Private and Public Differences

Private and public sectors differ significantly in their operations in Japan. The private sector vendors compete in offering data from newspapers, industries, and specialized material, but their activities are somewhat standardized through the industry association, DINA. Listings of the private sector vendors of databases are published commercially in an annual by Tōyō Keizai. Private vendors are costly which hampers their use from overseas, but even greater difficulties concern the standards of and access to public information offered by various government sources.

The public sector offerings of databases are fragmented among various jurisdictions. According to a Japanese government council attended by the Chair of this task force, a March 1991 report urged adoption of a five-year plan to coordinate among various ministries and agencies in charge of NACSIS, PATOLIS, JICST, and other sources of public data and grey material. Only after better coordination of domestic use did the council members envision a common means of future international offerings of government data.

ii. Standards and Utilities

As the database and telecommunication industries develop, users and vendors alike must find common standards. The condition of these standards and utilities is changing rapidly as the interested parties pursue discussions aimed at greater uniformity.

a. Unicode

Unicode is a newly developed character set that seeks to accommodate all the writing systems of the world's living languages. It was developed initially by a consortium of firms including IBM, Apple, Microsoft, Hewlett-Packard, Xerox, and Next. The consortium formed its own separate company, Unicode, Inc.

Unicode challenged existing projects. After the effort began, several individuals sought to tie the project to a prior effort of the International Standards Organization (ISO) on the so-called "ISO 10646" that had been discussed for years but had not received widespread support for its approval or adoption.

In July 1991, an independent steering committee called the Chinese, Japanese, Korean/Joint Research Group (CJK/JRG) was formed with representation from Japan, Taiwan, Hong Kong, the People's Republic of China, South Korea, and the United States. The group agreed on cooperation for CJK character sets.

In 1993, both Unicode and ISO 10646 was expected to appear in final versions for implementors. Use of the new character set is expected to spread rapidly after 1994 when Unicode devices are scheduled to appear. Already in 1993, Microsoft intends to offer its NT operating system with support for Unicode. However, substantial problems also remain according to the experts in Asian countries.

Unicode is likely to become a strong contender to replace the existing U.S. Asian character set known as "EACC." EACC is now used by RLIN, OCLC, and the Library of Congress, which differs from the standards in Japan known as "JIS." While the replacement of EACC is likely, some speculate that JIS and even the long-standing ASCII code may face a challenge from the new Unicode character set.

b. Centralized Bibliographic Utilities

Centralized databases of bibliographic information intended to be used by a wide variety of users exist in only small number of places. These databases, located usually on one large computer, rarely offer data in Japanese.

In North America, OCLC, RLIN and Utlas are the only such systems which provide for and include data in Japanese (see Glossary for more information). As their total number of Japanese records, OCLC has about 200,000, RLIN has 500,000, and Utlas has 2,000,000. Utlas is the only North American system which currently has loaded the complete (1957 to present) National Diet Library MARC file. Because Utlas uses Japan MARC format, it is used almost exclusively by Japanese libraries and only NACSIS in Japan provides a database similar in size and content. Since OCLC and RLIN use US-MARC, they are used widely throughout the United States and Canada.

c. Networks in Local Systems

Many local library systems in North America include Japanese data only in romanized form. Local systems are installed within one library for the use of that one library or a group of libraries which use the machine collectively. Local system vendors have not yet been able to provide full Japanese support on their local systems although the firms, Innovative Interfaces and Dynix, have announced such support.

Local system vendors do already support networking among the various installations of that local system. This activity allows users of such a network of local systems to inquire on each system one after the other when looking for material. Once Japanese support is available, such network activity could be extremely helpful to researchers who have the appropriate access. Many such local library systems are also now available on Internet and a list of such sites is available through Archie, the query system for searching the files available for anonymous transfer over the Internet.

d. Z39.50

This is the number of a new and much discussed standard from ANSI (American National Standards Institute) that will provide for the "seamless" interconnection of retrieval systems. In other words, this standard will provide for a necessary basis to allow software manufacturers of all kinds, and not just systems for bibliographic retrieval, to build systems that will communicate with each other in ways invisible to the user.

If the user regularly relies on one particular retrieval system in searching for bibliographic data, then this user will be able to extend a search to other systems (on other kinds of computers and supported by other kinds of software) without changing the search commands that are seen on the familiar system. In essence, Z39.50 provides for the automatic conversion into and out of any system which has implemented it for all search arguments and search results.

e. ISO/DIS 10646

The ISO standards generated the efforts to refine a character set known as ISO/DIS 10646. Unicode uses a subset of this standard although further efforts are underway to meet the requirements of each Asian country. In Japan, ISO/DIS 10646 is the responsibility of professionals supporting a CJK Character Repertoire under the auspices of NACSIS. The on-going negotiations and contacts among Chinese, Korean, and Japanese researchers involves continuing efforts to standardize usage. However, the problems of Unicode, ISO/DIS 10646, and other new character sets are yet to be resolved among users, software developers, and authorities.[5]

B. Access from Overseas to Japan

Overseas access is growing more slowly that domestic access to Japanese databases. The Japanese industry association (DINA) reports that 226 vendors made their services available overseas by July 1991. Most private vendors plan to offer their value-added services overseas, but various problems slowed such offerings. The Database Promotion Center (DPC) wrote that problems for overseas services included Japanese language, system standards, domestic focus, service costs, transmission methods, staff personnel, kanji mode input, and various other difficulties.[6]

The technical means now exist to gain overseas access to Japan's on-line services. By placing international calls and modem dial-up, or more likely with better access through network gateways, a library or researcher can already use some services from overseas. Particularly promising are the uses of Internet-related gateways that might improve use of electronic mail and file transfer protocols (FTP). However, the costs and technical skills remain high for using such gateways as UUCP, DASNET, or DECNET and great difficulties occur in entering Japan.

The existing technology indicates that possible use of Japanese databases from overseas is frustrated more by organization and coordination than by specific technical matters. A high priority is the unfettered access to Japanese organizations through Internet and other means of electronic information connections.

i. Studies of Demand in the United States

Japanese research organizations commissioned several studies to gauge the growth of U.S. requirements for use of information about Japan. Government, private industry, and researchers are studying the issues of access and flow to information on science, business, and other concerns about Japan.

a. Mitsubishi Research Institute

A 1989 comprehensive study by the Mitsubishi Research Institute (MRI) was sponsored by the Japanese Science and Technology Agency. The study emphasized that not only specialists but also the American public are beginning to demand more Japan-related material.

MRI researcher and former DINA President, Takayasu Miyakawa, analyzed data on the U.S. in his October 1992 speech to the Fifth Japan-U.S. Conference on Libraries and Information Science in Higher Education. Miyakawa divides various groups of this American public into first, the users of special libraries or information centers, second, the librarians, intermediaries, and specialists who staff such organizations, and third, the general public who increasingly demand information about Japan. In his summary, Miyakawa notes that agencies on the Japanese side wait for specific requests for material but believe that not enough requests are made.

The MRI study found that half of the U.S. science researchers inquiring about Japan relied on the indexes of specialized journals and a third directly contact Japanese researchers in their fields. However, the key groups on the U.S. side divide into researchers who are satisfied with personal contacts and librarians who rely on commercial databases and remain dissatisfied with the existing resources.

b. Database Promotion Center

The Japanese Database Promotion Center (DPC) offers the annual publication of the Database Whitepaper (Dâtabêsu hakusho) that regularly reports on industry activities. In a March 1992 survey, the DPC asked about 9% of the over 3000 members of the Special Library Association about database use in America. The survey found that current U.S. demand for databases on Japan is met largely by non-Japanese sources.

The 1992 DPC survey indicates increased demand for materials. A subgroup of about 195 cases said they used Japanese information, and were likely to use such sources more often in the future. The following sources are used: reference materials produced outside Japan, (76.4%, 71.4% likely in the future), databases produced outside Japan (71.3%, 75.7% likely in the future), university or public libraries (53.8%, 47.6% likely in the future), databases produced in Japan (21.0%, 60.5% likely in the future), and direct contact with Japanese information sources (16.4%, 41.1% likely in the future). The last two figures led DPC to acknowledge a growing demand for Japanese databases.[7]

c. National Institute for Research Advancement

Japan's largest think tank, the National Institute for Research Advancement (NIRA), has begun a project to prepare for use of networks. Plans include Internet connections and a meeting of leading experts in the area of network design.

In late 1992, a team from NIRA visited leading research organizations in the U.S. to plan the NIRA Library and to inquire about possible exchanges of materials from Japan. A conclusion of the NIRA study as well is that most organizations require materials in English about Japan, but a growing number seek direct access to on-line materials and databases either through existing services or elsewhere.

ii. On-line Access through Network Gateways

The use of network gateways provides a potential means for gaining low cost access to Japanese on-line resources. Transfer of Japanese language material is possible through gateways in UNIX and other computer-language environments, particularly with the widespread use of MacIntosh personal computers and improved laser printers capable of supporting kanji output. In the United States, electronic mail networks of Internet and Compuserve have greater usage than their Japanese counterparts.

a. Internet and other Gateways to Japan

Gateways are allowing greater access to Japan. Internet is partly connected through Keio University (WIDE), the University of Tokyo (TISN) and other academic networks. Bitnet is available at some universities, but with limited access to the Internet. Other academic networks such as UUCP, DECNET and DASNET assure electronic mail connections for university and other research institutions.

Internet connectivity remains a critical problem in Japan. NACSIS and other agencies seek full operations for educational institutions by 1993, but many problems remain with the complete and easy operation of the Internet into Japan. Various groups are forming to seek better connectivity, particularly for groups in Japan not tied to leading national universities. Outside the country, the Pacific Neighborhood Project mentioned below is pursuing parallel efforts not only in Japan, but throughout the Pacific Basin. The Internet Society in particular meets annually and forms the focus for efforts to assure international access to places including Japanese research organizations.

b. Handling Japanese Characters

Experiments in handling Japanese language materials have created a small community of users on the Internet in the United States. Materials available on-line include useful files that provide technical instructions to access materials from Japan and in Japanese. The most recent version of JAPAN.INF explains the transfer of Japanese kana and kanji, the use of electronic mail with these characters, and reinstalling your computer to handle Japanese text. The updated document is available at two FTP sites, ucdavis.edu (128.120.2.1) and msi.umn.edu (128.101.24.1). The author, Ken Lunde, has produced a new volume extending and explaining the background for such issues in the book Understanding Japanese Information Processing.[8]

c. U.S. Government and Other Projects

In the area of Japan-related information, technical reports and scientific developments in Japan have extensive coverage partly due to U.S. government support. The efforts of the National Technical Information Service (NTIS), National Science Foundation (NSF), and Office of Naval Research (ONR) have all made information on science more readily available.

NTIS provides various Japan publications (phone: 703-487-4650). NTIS works with the Department of Commerce, Japan Technology Program (phone: 202-482-1288) which produces a regular, high-quality bulletin entitled "Japanese Technical Literature."

NSF provides access and funding for several projects. NSF supports on-line access to the Japanese databases of NACSIS through workstations in Washington. NSF also funds projects such as that of the Japan Technology Evaluation Center which produced an April 1992 survey of Japan. This survey of "Database Use and Technology in Japan" concluded that Japanese image technology would provide advantages in developing future databases, particularly based on multimedia and optical disk storage technologies.

ONR supports an office in Tokyo that follows developments and conferences in science and technology. Dr. David Kahaner files regular reports available on the Internet for retrieval by anonymous FTP from site cs.arizona.edu [192.12.69.5] (directory kahaner.reports). With ONR support, Dr. Rick Schlichting of Arizona University also offers collections of past articles from his moderated topic (comp.research.japan) that discusses computing in Japan.

d. The Pacific Neighborhood Project

The Pacific Neighborhood Project is a program initiated at the University of California, Berkeley, to develop international agreements on scholarly exchanges of information through shared use of computing and communications technology. In January 1993, the organizational meeting attracted 80 participants from fifteen countries of the Pacific Basin (including Japan) and broke into various task force groups. These groups discussed Internet connectivity, standards and agreements for library and database access, and applications for various educational institutions. The Director, Professor Curtis Hardyck, stated in his opening comments that the tasks are not primarily technological ones but rather effective use the technology for database standards, access, and reciprocity among the countries involved.

The Project met in August 1993 along with the meetings of the Internet Society and have a second formal meeting in January 1994 in Hong Kong. UC, Berkeley, will act as the initial administering agency and provide a steering committee for the project until a multi-national Consortium is formally established.

iii. Off-line Resources on CD-ROM

The outlook for off-line database use promises rapid growth in Japan. At present, on-line databases compose about 90% of the total and CD-ROM costs remain high. The forecast is more favorable as initial investments in CD-ROM technology will increase demand and push costs down, particularly for those database resources that do not require constant revision. The annual catalog publication available from Tōyō Keizai surveys the foreign and Japanese offerings of CD-ROM.

iv. Fax and Mail Transfers of Full Text

Many parties have the common difficulty of getting full text retrieval of research materials. Besides mail, requests by fax may speed retrieval. Researchers and librarians may wish to seek sources for full texts because of the reports that Japanese agencies do not believe such requests are made with enough frequency and they claim to be willing to respond to overseas requests. Direct contacts remain among the most effective ways to assure delivery of full text.

For science and technology materials, JICST offers a service for requests made by fax and then mailed overseas from Tokyo. The Science and Technology Agency also created a JICST-E database of English translations, and their services also offer full text copying of timely Japanese originals provided upon request to JICST offices in Tokyo.

The National Diet Library may also collect two-thirds of so-called "gray literature." According to a 1988 survey of the Science and Technology Agency (STA), 211 research organizations responded that they sent materials to NDL including the following categories: research reports; conference proceedings and preprints; technical reports and private or internal reports; articles in scholarly journals; doctoral dissertations; and government publications. While one-third of difficult to obtain materials was exchanged directly between the Japanese organizations and U.S. counterparts through inter-agency agreements and special arrangements, this survey found that 40% of the Japanese organizations had not been asked for materials which they can provide without high costs or copyright infringement problems.

3. CONCLUSIONS: Availability of Resources

Three areas of priorities emerged from this report. First, pilot projects are a means to seek common standards, detailed planning, and pooling of technical skill. Second, these projects will best work by using access to resources available through the Internet as a gateway to Japan and its databases as well as inexpensive sources of off-line CD-ROM sources. Third, leading organizations can coordinate their efforts to train librarians and researchers with up-to-date information related to databases in Japan.

A. Pilot Projects for Technical Upgrade

Several pilot projects have already begun. These projects explore the limits of connectivity and access. The following are a sampling of projects underway in research libraries using database or related technology to gain better access to materials from Japan.

i. Ohio State University-Duke University

The OSU libraries, in cooperation with Duke and other universities, have begun a Japanese Text Digitizing Project. This project uses image processing on MacIntosh computers to transmit Japanese texts. For example, the table of contents of leading scholarly journals will be made available to scholars on campus and eventually over the Internet as well. Through use of FTP transfer, the project seeks to increase sharing of materials and overcome barriers in remote locations.

ii. North Carolina State University

The NCSU libraries also have a Digitized Document Delivery Project. This project will study the technical feasibility of machine-readable format for a variety of library materials including those in Japanese.

iii. Biotechnology Information Education Demonstration Project

A joint project of four Midwest universities seeks to pool information on biotechnology. By applying the "knowledge management" concepts from medical libraries, the project is supported by Iowa State University, Indiana University, the University of Wisconsin-Madison, and the University of Minnesota.

iv. Association of Research Libraries

The ARL has supported pilot projects in order to create a model for all area-based research in the Association's libraries. The projects include some efforts above and considered specific strategies to best manage the future of Japanese collections in U.S. research libraries. In conjunction with the findings of NCC reports, the ARL proposes to design pilot systems and models for information delivery using certain selected resources. These models would address hardware and software requirements, telecommunications capabilities, training, resource sharing capabilities, copyright and licensing issues, costs, and the impacts on local collections and users.

B. Access to Resources from Japan

Concerns about assured access to resources from Japan span the Pacific. On the Japanese side, the 1987 publication of the book, Kokusai jōhō masatsu (International Information Friction), raised awareness of the growth of database information and the potential for reactions from overseas. From overseas, related efforts emphasized the need for openness. Organizations such as the Electronic Frontier Foundation seek to assure First Amendment rights to electronic media in the United States. Similarly, individual members of the Internet Society seek openness by extending their electronic network internationally.

In specific cases, extensive resources are already available in the United States. University libraries such as at Columbia, Harvard, Stanford, and the campuses of the University of California are maintaining traditional collections as well as making special efforts to obtain recent documents. However, the costs and timeliness of current

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materials are increasing rapidly with inflation and yen appreciation. To overcome growing problems, efforts at the national level become important.

i. National Science Foundation

The National Science Foundation (NSF) is offering U.S. scientists and engineers access to scientific information from Japan. In cooperation with NACSIS, the three terminals at NSF provide on-line access at no charge to the science databases associated with the Ministry of Education. The system does not allow remote searches of NACSIS, but the NSF employs an operator to perform searches by request. NSF also offers the Science and Technical Information System (STIS) with useful information about grants and resources. The STIS services are available on the Internet (stis@nsf.gov).

ii. Library of Congress

The Library of Congress (LC) has various projects to improve access to Japanese materials. Key projects of interest include the conversion of machine-readable records and the opening of a new document center.

a. J-MARC

In March 1993, the LC Cataloging Distribution Service is scheduled to begin distribution J-MARC records for the current 1993 period. The MARC records created by the National Diet Library for Japanese monographs and converted by LC to the US-MARC format. The data in these records comes in both romanized and vernacular form. The romanized data uses Hepburn romanization, and the vernacular is sent in multiple 880 fields using REACC codes.

According to sources on the "EASTLIB" newsgroup, the retrospective records will also be available. About a million records will cover 1969-1992, but the initial offering now available of 60,000 records only covers 1993 at a subscription cost of $2200 ($2250 outside North America) and can be ordered through Kinokuniya (tel: 81-3-3439-0123, fax: 81-3-3439-1093).

b. Japan Documentation Center

The Library of Congress is supporting a new organization within the Asian Division to provide documents on contemporary Japan. With the support of the Center for Global Partnership, the Japan Documentation Center (JDC) will develop a collection of materials on contemporary society for LC constituents including the U.S. Congress, federal agencies, and academic researchers. The JDC will work in tandem with a Tokyo Acquisitions Facility that collects and transfers current materials to Washington for use of the new operation. By January 1994, these two offices will choose staff to implement the planned operations of collection, bibliographic control, and distribution of materials in electronic and other forms.

C. Training in Skills

Training is vitally needed in assuring basic skills in telecommunications, networks, and database availability. Towards these ends, promising progress has been made by leading organizations.

i. Japan Foundation

In a May 1991 library survey, Michael Paschal writes that coordinated development and open access could be enhanced by increasing training opportunities. Paschal, a Research Associate at the Japan Foundation, finds that vast differences exist small libraries seeking access to materials and large research collections with greater resources, but both groups believe that their work was hampered by a lack of training opportunities.

Towards this end, the Japan Foundation supported a two-day workshop on March 23-24, 1993, that included a CEAL session on Japanese databases and technology. The Japan Foundation survey found that among training opportunities, librarians were especially drawn to the activities of the Committee for East Asian Libraries which conducted this recent workshop.

ii. Committee for East Asian Libraries

The CEAL Subcommittee on Japanese Materials pursues various training activities which may improve knowledge about on-line materials and databases. In March 1993 sessions, CEAL meetings showed that more attention must be paid to learning about the advances in new technology and resources.

The NCC task force recommended continued training opportunities be made available through CEAL, its Subcommittees, and the network of individuals in organizations related to Asian studies. Existing organizations related to CEAL and the Association of Asian Studies provide the largest groups with which to attract and encourage dissemination of skills and information about Japan. The first steps to train and educate librarians and end users have begun and require further such efforts.

iii. NCC Subcommittee on Electronic Information Resources

The findings and recommendations of this report on training as well as other issues will be pursued by the related NCC Subcommittee. In keeping with NCC objectives, the Subcommittee will also coordinate with existing efforts including those of CEAL, ARL, and LC. Individuals with concerns or comments are encouraged to contact the co-chair and author of this report (Internet: sandersn@virginia.edu).

GLOSSARY OF KEY ACRONYMS AND TERMS

ARL: The Association of Research Libraries is the leading organization seeking to advance the goals of libraries with major research collections. ARL made efforts to develop four scenarios for different collections in Japanese studies and supports a joint project with the NCC to study pilot efforts which use electronic information resources.

CEAL: The Committee for East Asian Libraries, Association of Asian Studies, is a leading meeting of librarians affiliated with the Northeast Asian Council.

DINA: The Japan Database Industry Association (DINA) is the industry association that coordinates among vendors and organizations related to databases. This largely private sector group is the central industry group to set standards and discuss industry-wide concerns.

DPC: The Database Promotion Center is a foundation originally established by the Ministry of International Trade and Industry (MITI). At present, DPC is a semi-governmental agency that publishes the well-known annual Dātabēsu hakusho (Database Whitepaper).

INTERNET: The leading international network that combines and replaces many networks such as ARPANET, NSFNET, and MILNET. The ARPANET was the primary predecessor of Internet started by the Department of Defense, Advanced Research Projects Agency (once called DARPA), but ARPA is no longer a primary supporter. Instead, a series of national and international agreements exist through the Internet Society. In the future, the NREN is expected to become the successor network with higher speed and volume capacities.

JICST: The database of the Science and Technology Agency used to distribute information and articles in Japan. JICST-E is specifically devoted to English-language materials in translation, but the various JICST database sections in Japanese contain more complete and timely information than the translated materials.

J-MARC: Japan MARC is an encoding scheme for Japanese bibliographic data in machine-readable form. This Japanese encoding scheme differs from that of the United States known as US-MARC, although the Library of Congress will offer a conversion of National Diet Library data available through Kinokuniya bookstores.

JUNET: A Japan-university network that coordinates addresses for educational, government, and corporate electronic mail.

LC: The Library of Congress (LC) is active in support of projects to improve Japanese collections and enhance coordination between the United States and Japan. In addition to the over 700,000 volume collection, LC has agreements with the National Diet Library and other agencies to enhance resources available on contemporary Japanese society by creating a new Japan Documentation Center.

NACSIS: The National Center for Science Information System (NACSIS) is the organization affiliated to the Ministry of Education responsible for providing bibliographic and full-text databases to research libraries in Japan. The NACSIS databases especially seek to collect materials on dissertations, academic meetings, and other educational materials in NACSIS-IR and organize bibliographic data in NACSIS-CAT.

NCC: In the United States, the National Coordinating Committee (NCC) on Japanese Language Resources began meetings in February 1992. NCC objectives are to continue the work of coordinating, developing, and locating funding for American projects in cooperative Japanese collection development, improved bibliographic access, and education in Japanese librarianship; to gather information and articulate the needs of librarians, scholars, and others in relation to information needs; and to expand the work of advising and collaborating with funding agencies in developing relevant and valuable programs.

In 1992, the NCC recommended specific actions including the immediate application for several grants: one, to assure the equitable distribution of expensive multivolume sets throughout the country, and the other, to assure the widest possible dissemination of the National Union List of Japanese Periodicals, both to libraries and scholars at institutions with less representation than major research centers, and in both print and online formats. It is an important characteristic of the working of the NCC that it is expanding to include in its work members of the larger library and scholarly communities. With the support of the Center for Global Partnership and U.S.-Japan Friendship Commission, NCC plans to issue a national plan to coordinate Japan-related resources and needs of concerned libraries in the United States.

NDL: The National Diet Library (NDL) is the central depository and national library of Japan. Through agreements with the Library of Congress, the NDL has provided J-MARC records and exchange of a variety of Japanese materials.

NREN: The NREN (National Research and Education Network) bill was signed by former President George Bush in December 1991 laying the foundation for an information superhighway. Funded by a bill drafted by Vice President Al Gore, NREN is designed to streamline and coordinate information networks in the United States.

OCLC: Online Computer Library Center, Inc., is a bibliographic utility used widely by libraries with Japan-related resources. According to a May 1991 survey analyzed by Michael Paschal of the Japan Foundation, nearly all surveyed institutions belonged to one such utility and 59% belonged to more than one. A breakdown showed membership as follows--OCLC, 79%; RLIN, 26%; INTERNET, 49%; and others, 12%.

RLG: The Research Libraries Group, Inc., is a not-for-profit consortium of universities, archives, historical societies, museums, and other institutions devoted to improving access to information that supports research and scholarship. The consortium owns and operates the Research Libraries Information Network (RLIN).

RLIN: The Research Libraries Information Network (RLIN) provides information access and management needs to both its members and nonmember institutions and individuals worldwide. The RLIN database has over 50 million records representing materials in over 350 languages, including unique resources (such as early printed books, research in progress, art sales catalogs, and archival collections), and citation files offering article-level or item-level access. RLIN also supports description of materials in the following non-Latin scripts: Arabic, Cyrillic, Hebrew, Chinese, Japanese (both kanji and kana), and Korean. Some of the providers of the citations files also agree to provide document delivery directly through RLIN, with Ariel (tm), an RLG-developed document transmission software that sends and receives scanned documents over the Internet, as a document delivery mechanism.

RLG EAST ASIAN COLLECTION: The RLG East Asian collections (which includes over two dozen of the largest East Asian collections in North America) did a survey in 1989 on about 30 Japanese databases supporting the humanities and social sciences funded by the Kagaku Kenkyûhi Hojokin (Scientific Research Grants supported by the Ministry of Education). The survey asked members which databases would most likely benefit scholars and librarians in RLG member institutions if they were made available on RLIN. As a result, RLG obtained the Union Catalog of Scholarly Periodicals in Japanese Language, produced by NACSIS (National Center for Science Information System), which RLG plans to include in the RLIN database and make accessible to anyone with an RLIN search account. Where appropriate, RLG may be a vehicle for making these resources available through RLIN and Ariel.

UTLAS: Utlas, International, Inc., is a bibliographic utility used by most libraries in Canada as well as approximately 70 private university libraries in Japan. Utlas maintains a database of 50 million records with bibliographic data in 200 languages in roman script only, as well as a database of information in Chinese, Japanese, and Korean. The latter CJK database contains approximately 2 million records, the majority of which are in Japanese.

ENDNOTES

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2. Andrew Pollack, "Now Its Japan's Turn to Play Catch-Up," New York Times, November 21, 1993, Business Section, p. 1, 4.

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Corporate Identity:
Telecom as a major stakeholder in Australia's deregulated telecommunications industry

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University of Southern Queensland
and
Selina Hainey, Department of Mass Communication, University of Southern Queensland.

1 ABSTRACT

"Telecommunications is perhaps the key technological battleground on which the struggle over the future society will be fought" Ian Reinecke.

The following paper analyses the current structure of telecommunications in Australia in terms of the establishment and the history of Telecom. The Australian telecommunications industry has assets of over A$25 billion, generates sales revenue of A$11 billion and pre-tax profits of A$2 billion: about 3% of Australia's GDP, making it a highly lucrative industry which impacts heavily on all Australians. Ninety-four percent of Australians have at least one telephone. Within the current state of deregulation in the telecommunications industry in Australia this paper looks at the current and future elements of the telecommunications industry and determines the effects of the introduction of competition - namely the Canadian owned OPTUS - on Telecom's previous monopoly.

2. HISTORY OF THE AUSTRALIAN TELECOMMUNICATIONS INDUSTRY

The telecommunications industry has seen a number of changes in its relatively short history. After World War II, Australia nationalised its international telecommunications under the Overseas Telecommunications Commission (OTC). It wasn't until 1975 that Telecom assumed the sole responsibility of Australia's domestic telecommunications from the Postmaster-General's Department and formed Australia Post in the process.

To cater for the introduction of Telecom, the Telecommunications Act was passed requiring Telecom

1 to be responsible for the provision, maintenance and operation of telecommunications services in Australia which best meet the social, industrial and commercial needs of the people in this country.

2 to make its services available through the country so far as it is practicable

3 to generate revenue to cover its yearly expenses and to provide not less than one half of its capital requirements

4 to keep its services up to date and operating efficiently and economically, with charges as low as possible. (Telecom Australia, 1992, p.1)

In 1984, Australia entered the realm of satellite communications with the launch of AUSSAT. Under pressure of super-normal profits and inefficiency, the Australian Government decided to deregulate the telecommunications industry. In 1991, Telecom and OTC were amalgamated and formed the Australian and Overseas Telecommunications Corporation (AOTC). The monopoly of Telecom was broken into a regulated duopoly with the second carrier Optus purchasing AUSSAT. Competition began with the launch of Optus's marketing campaign in 1992. To implement the requirements of deregulation, the Telecommunications Act of 1991 was put into place.

2.1 TELSTRA

A name change for Telecom in April, 1993 saw it become Telstra Corporation Limited. It replaced AOTC and trades domestically as Telecom Australia and offshore as Telstra. The new corporate name was put in place as part of an overall change of corporate identity to enable customers and all others which deal with Telecom to become more aware of the significant changes taking place within the corporation to met competition and aim at providing service excellence. The corporation is 100% owned by the Australian Government.

3 EFFICIENCY

Under threat of competition from OPTUS, Telecom has achieved sustainable

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improvements in efficiency, albeit from a low base. In 1989/90, the total factor (labour,materials, and capital inputs) productivity gain was 9%, three times the national average. During the same period Telecom reduced its staff by 3.2%, while the number of telephone services in operation and the volume of calls increased by 3.3% and 6.9% respectively. (Summons, 1990 p. 80). Following the introduction of Optus, the efficiency of Telecom and indeed the entire telecommunications industry in Australia has increased dramatically. Telecom has expanded its public relations campaign to cater for a previously and relatively ignored market sector - the general public.Consumers now have a wide range of services available to them at a fraction of the previous costs, supported by good customer service and prompt and friendly liaison staff.

3.1 EMPLOYMENT

Once one of Australia's biggest employers, Telecom is aiming to increase its efficiency by shedding staff. After reaching an employment peak in 1985, Telecom is now in the process of changing from a labour-intensive industry to one which places more emphasis on capital investment. Administration work is centralised and much of the field work is carried out by sub-contracted crews to further reduce employee numbers. With the advent of competition through Optus the number of Telecom employees is expected to be further reduced to less than 77 000 staff.

3.2 CROSS-SUBSIDISATION

Under the regulated system, metropolitan subscribers paid extra rental to fund country services. Business customers were subsidising the private consumers, To have a telephone connected in the country a maximum of $1 400 would be paid by the subscriber while Telecom paid the remaining costs of around $25 000 per service. Over recent years Telecom has been rushing to finish its community service obligations by connecting the country before the market was deregulated. Legal action can be taken it does not meet these obligations, as it was by the Northern Territory Government in 1991.

With deregulation, a user pays systems would come into effect with metropolitan and business subscribers the winners with lower rates.

3.3 PRICING

Despite public opinion the price of telephone calls in Australia is one of the lowest in the world and price rises are almost always kept below inflation. While local calls are likely to remain unchanged under deregulation, long distance calls are expected to fall by 40% within the first five years and within a decade have decreased by up to 60%.

International calls are cartelised and though Australia's international calls are relatively inexpensive, there is still room to decrease prices.

Within Australia there is currently a price war of sorts between Telecom and Optus with Telecom initiating a program of price cuts. Should price discounting continue with reductions reaching as much as 15%, Optus will only begin to draw even by the end of 1997.

3.4 PROFIT

When Telecom held the monopoly in telecommunications its highest operating profit in any one year was $1.29 billion in 1989/90. Deregulation has already seen profits reduced. For the year ending 30 June 1993, the first full financial year for the Telstra Corporation, net profit was $904.8 million.

4 TARGET AUDIENCES

It is implied that because Telecom operates within the public section it is seen to be inefficient, overstaffed and unproductive and that only through competition in the private sector can efficiency and productivity be achieved.

4.1 DOMESTIC MARKET

Apart from its services to multinational and small business clients Telecom has endeavoured to promote its services to the domestic market. Consumers are now able to demand and receive competitive pricing, various account keeping/payment facilities and are able to choose from a wide range of customer services.

With approximately 70% of Australia considered 'remote' with less than one person per 10 kilometres (Wilson, 1989, p.30) Telecom's servicing of these areas is significantly less than the populated eastern and south western Australian coasts. Within the remote areas of Australia, indigenous people make up about 14% of the population (Wilson, 1989, p.30). However their communities are unable to afford telephones and it has been stated that Telecom gives priority to larger more affluent communities.

According to a 1984 Task Force on Aboriginal ands Islander Broadcasting and Communication . . .

> "aborigines are the most disadvantaged major segment of Australian society with respect to access to communications and the social and economic benefits which they provide. (Wilson, 1989, p. 31)

Facilities have also been made available to meet the needs of disabled persons and ethnic minorities.

4.2 COMMUNITY INVOLVEMENT

Telecom is conscious of the importance of meeting its nation-wide environmental obligations and, in accordance, a corporate environmental plan was released in July 1993 which documents the responsibilities and commitments to protect the natural environment and cultural heritage.

Community involvement in the "Book Muncher" directory recycling program continue to grow, eventually minimising the number of collected books going into landfill. Staff education and training regarding their responsibilities to the environment is one important element of Telecom's concern for the environment.

Particularly important in maintaining interaction between consumer groups and thus aiding Telecom to provide appropriate customer services are the customer consultation groups, such as the Telecom Consumer Council (TACC) and the Telecom Small Enterprise Policy Panel (TSEPP). Consumer representatives have also contributed to the development of Telecom's customer information which has created an important initiative with TACC and TSEPP seeing the development of a Code of Practice for Telephone Services. The Code includes information for terms and conditions, levels of service, features, rights and Telecom's obligations. It addresses all aspects of service from the point of view of both the residential and business customer.

A Payphone Access policy was developed through the Consumer Councils, including representatives from People with Disabilities (NSW) and the Consumer Telecommunications Network. The policy, released in May 1993 ensures that payphone accessibility, use and location are suitable for those members of the community with special needs. Social and policy research in telecommunications support continues through program funding to research institutions, grants to academic researchers and community based groups and post graduate awards to Masters and Doctorial students.

Telecom also supports a wide range of community events and activities both through corporate sponsorship and staff involvement. Telecom announced its continuing support for the Australian Olympics, Commonwealth Games and Women's Hockey teams. Other major sponsorships include the Sydney Dance Company, Lifeline, and Landcare. Also a number of events directly related to the telecommunications industry have been supported, including the Australian Quality Awards, Women in Technological Careers, the Telecom and Australian Government Small Business Awards which is chartered to promote the development of small business, recognise excellence and contribute to the Australian economy. (Telecom Australia, 1993)

5 CONSUMERS

Being Australia's largest telecommunications carrier, providing the economy with the infrastructures, products and services required for its prosperous growth, Telecom is also the primary means of social communications and interaction, upon which the cohesiveness of Australia's society rests.

Within its charter Telecom is charged with meeting the social, cultural and industrial telecommunication needs of all Australians, delivering those services nationally through uniform affordable rates whilst keeping services efficient, economic and sustainable. The introduction of Optus has focused Telecom's attention more onto the domestic market ensuring that it is seen as by all, as an all Australian organisation.

5.1 TELECOM SERVICES

Telecom has begun to extensively expand its customer base to include

Telecard

> allowing customers to make calls from anywhere in the world and have calls debited to a nominated Telecom Australia account.

Phonecard

> a prepaid card that allows customers to use payphones without the need for money

Consumer Information Material

- A Useful Guide to Phone Call Charges
- Answering Your Questions About Telecom
- Dealing with Unwelcome Phone Calls
- Keep the Lid on Your Phone Costs
- Organising Your Phone When You Move
- Silent Lines for Telecom Customers

Telecom Faults: How they happen: What to do.

What You Need to Know about 0055

Business Links

provision of call transfer, call diversion and conference calling.

Budget Payment Card

allows accounts to be pre-paid by instalments

Pensioner Benefits

40% savings in the first 10 local calls each month, a $50 reduction on new telephone connection fees and a $25 reduction on telephone reconnection fees.

Easycall

services available through any touchphone from 50 cents per week include call waiting, call diversion, call inquiry/conference, call control, abbreviated dialling and delayed hotline.

Subscriber Trunk Dialling

allows a customer to call anywhere in Australia at standardised rates

International Dialling

allows overseas dialling with/out operator assistance

0055 Network

the availability of pre-recorded information/entertainment

Telecom Operator

wake-up calls, directory assistance, ring back price, reverse charge, faults and service difficulties and emergency numbers.

Flexi Plans

customers can list five frequently called long distance and international numbers and receive special rates on those numbers.

Bill Paying

Ordering Services of Telecom Products

Silent Lines

In the near future Telecom plans to introduce

Intelligent Networking

customers can choose a configuration of service to meet their specific needs

Telecom Management System

monitors and directs all messages within the Telecom network

Jindalee Early Warning System

an over-the-horizon early warning system that can be used to prevent drug smuggling, illegal immigration, and which can help provide more accurate weather information and assist in search and rescue operations

QPSX/TELECOM FASTPAC

the use of high speed technology for the transmission of data incorporating the use of intelligent video screens and electronic directories.

6 ENTER THE COMPETITION - OPTUS

With deregulation Optus entered the telecommunications industry in Australia as second carrier opening a single consumer market and providing people with a choice of phone service.

On January 31, 1992 Optus was awarded its license to operate in Australia. It had just five months to launch its name into the Australian market place. Initially two areas were targeted, the mobile phone network and long distance telephone services.

A corporate personality was required.

Both technology and price structure were considered too difficult to sell and so Optus focused its concern on the people of Australia - their problems, satisfaction, and their need for an overall customer service.

With their personality determined, in May/June 1992 Optus introduced itself through its "HELLO" campaign. "IT'S FOR YOU" followed in July/August as part of its continuing push to form a relationship with its market. The campaign had already achieved high exposure for the organisation and had developed a positive personality for Optus, after three months, 89% of the business community and 86% of the residential market were aware of Optus, yet no product had been communicated to the target public. Its "YES" campaign attempted to singularly encapsulate the philosophy of Optus as a 'can do' company, both proactive and reactive to customer needs, giving meaning to "YES OPTUS". Optus had successfully positioned itself as a competitor that was innovative, friendly, and customer oriented.

6.1 EDUCATION AND TRAINING

Optus has established an education and training program to assist accelerated development of technical expertise in Australia committing $100 million within the next five years to the operation.

6.2 SUPPLIERS

Suppliers have contractual commitments to Optus and key guidelines have been developed to ensure that average Australian content of total capital expenditure will exceed 70% with Australian companies used wherever possible.

6.3 TARGET AUDIENCES

Mobile Phone Users

Long Distance Users

services are currently only available to selected regions although Optus hoped to have an Australia wide service by 1997.

Customer Services

International Operator Services

allows call charges to be billed directly to the caller, the receiver or a third party or to various call cards

Interlink

allows business to keep in touch with operations around the world at all times through an International Private Leased Circuits allowing large volumes of data to be transferred economically and securely.

Datalink

a high quality service for the transmission of data between Australian capital cities

Business Telephone Services

ISDN Services

high speed switched digital services providing cost effective data transmission, packet switched data and high quality voice communication.

Virtual Private Network Services

allows a multiple site business to treat its locations as a single entity enabling the use of a single general switchboard number, abbreviated dialling ands standardised equipment

Centrex

similar to PABX but switched over the Optus network offering full maintenance and support, elimination of capital expenditure and a full customisation of the service to met consumer needs.

Telephone Information Services

assist subscribers with account records and billing information allowing them to determine the most economical rate plan to use.

Informations Services

mobile users will have access to operator and information services including directory assistance, financial news and weather reports, call forwarding, call waiting, hold, transfer and conference calling.

Voicemail

electronic voice messaging service

Short Message Service

mobile users can have their phones used as paging units.

Mobilesat

a digital mobile telephone service that provides voice, data, facsimile and messaging functions

Satellite Services

an extension of the services previously operated by AUSSAT for television and radio broadcasting and pay TV service, provision of two way international television services in competition with AOTC using Intelsat and other satellite systems

Personal Communications Services

through the use of one phone number messages can be re-routed to provide call diversion, conference calling, and anywhere pick up.

7 CONCLUSION

Modest growth of around 6% - 6.5% is expected to occur in the Australian telecommunication industry over the next five years (James, 1992, p.85) AOTC and Optus will be able to compete internationally if niche markets can be established.

Telecom has already developed a specialist software market and through AOTC is exporting its expertise laying optical fibre lines in Middle Eastern countries.

Optus hopes to gain an overall share of the total Australian telecommunication service by the year 2001 and add an additional $2 billion to Australia's GDP in the next five years

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WIRELESS LOCAL LOOP AHEAD OF THE GRID

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1. ABSTRACT

Telephone service can be provided to remote areas by the use of rural radio telephone systems, however the lack of commercial power can make these installations prohibitively expensive without proper engineering and system planning for cost-effective use of alternative power sources. The authors briefly detail alternative power options, and then offer some options for reducing system costs when mains power is unavailable or unreliable.

2. ELECTRICAL POWER AND RURAL RADIO

Rural radio telephone systems have been used for a number of years throughout the word, providing basic telephone service to remote area where wireline extension was impractical or too expensive.

A limitation in the past has been the availability of reliable electric power at subscriber stations, and even at some central office (base) stations. All radio telephone base and subscriber stations must use some form of electrical power to operate, normally supplied by AC mains (commercial power). Demand for telephone service in developing nations is expanding at a faster pace than the electrical grid. If care is taken in designing rural radio telephone systems, the cost effect of extending service beyond the grid can be minimized.

3. ALTERNATIVES TO GRID POWER

Alternatives have existed for some time that allow radio based telephone equipment to be used when mains power is unavailable. Nearly all manufacturers of rural radio telephone equipment offer operation on DC power, which is easier to generate on site than AC. There are a number of ways to generate and store DC power at a scale suitable for radio telephone systems.

3.1 PHOTOVOLTAIC

Photovoltaic (solar) power has been available for years and proven reliable in this type of service. photovoltaics can be used for communications power in most of the occupied regions of the earth, but climate and geographical differences can make substantial variances in the cost to power a given load. Cost per watt for solar generated power remains high, and can even exceed the expenditure for a subscriber terminal if power consumption is excessive.

3.2 LOCALLY GENERATED POWER

Locally generated AC or DC power can be used to support the radio equipment, but battery storage must be provided for periods when the generator is not running. Most applications using locally generated power do not use AC power directly from the generator, but rather have a charger and battery system in the circuit. Use of locally generated AC power carries more risks of electrical spikes and surges from other loads on these small generating systems. Generator powered system are normally practical only when the power is also required for lighting or other services.

3.3 OTHER OPTIONS

Small a-electric (micro-hydro) systems have been used to generate DC power for communications, as have thermal generators. These options are generally quite expensive and not suitable for mass installations.

In certain cases storage batteries can power the radio without a means of charging on site. The batteries are rotated elsewhere for charging at regular intervals. This practice is used generally when equipment current consumption is minimal, and the need for telephone service exceeds the substantial cost of replacing discharge batteries with charged ones at regular intervals.

4. REDUCING COSTS WHEN ALTERNATIVE POWER IS NEEDED

There are ways of substantially reducing the costs of supplying non-mains power to rural radio telephone equipment without reducing the quality of service. We will examine several means of reducing the current consumption when designing a rural telephone system.

4.1 THE MYTH OF HIGH TRANSMIT POWER

One of the simplest ways to reduce power consumption is to reduce the radio output (RF) power of the base and subscriber transmitters to levels which will still reliably cover the distance between the subscriber station and its associated base station, without broadcasting any further than needed.

Most engineering formulae for determining radio path loss are very conservative in nature, and when applied to the generally short distances used in subscriber radio systems, call for much more RF power than is actually needed for reliable service.

A more realistic determination of the RF power needed for any given radio path can be made by physically measuring the fade margin available, using path test equipment in the radio band to be used. Another advantage of this method is that the path test set operator need not have the same advanced telecommunications engineering skills needed to calculate a radio path. These devices can be operated by any craft person normally employed by a telephone utility.

Experience has shown that 20 dB of fade margin is adequate in an analog 400 MHz FM rural radio system. Calculated path losses can indicate 15 dB or more loss than is actually present in a given radio path, requiring substantially higher transmitter power to achieve a 20 dB fade margin, with associated higher costs and power budgets.

4.2 ANALOG RADIO vs. DIGITAL RADIO

Another effective means of reducing power consumption in rural radio system design is the utilization of equipment that is inherently more power efficient. Both the type of radio modulation scheme used and the design of the radio system can affect the amount of power used.

When the number of subscribers to be served from a single base station is within the capacity of a trunked analog FM rural radio telephone system (typically 48 or fewer subscribers for 6 radio channels) use of this technology can yield benefits in power consumption. A modern analog subscriber unit design will use as little as 1 watt of current in idle condition, compared to 20 watts or more for currently available digital subscriber units, resulting in great savings when solar power must be used.

Since there are substantial differences in design of even analog systems, it is important to get accurate current consumption data from a manufacturer. Systems engineers should be sure to specify maximum DC consumption in tender specifications since high current consuming equipment can add substantially to system costs when alternative power must be used.

Digital multiplexed rural radio systems have a greater capacity and also better spectral efficiency (i.e., they can carry more traffic in a given amount of radio spectrum) than analog systems. But this is at a price of greater power consumption. Digital systems may often have reduced receive sensitivity compared to analog equipment, requiring higher transmit power to span the same distance.

5. OTHER ADVANTAGES OF LOWERING POWER CONSUMPTION IN RADIO SYSTEMS

An additional advantage of utilizing equipment with the lowest possible power consumption is increased reliability and decreased costs for equipment enclosures. Low power use is generally accompanied with less generation of heat, a common factor in breakdown of electronic components. The use of environmentally controlled enclosures or even fan cooling systems is generally not required with analog FM systems having an RF output power of 2 watts per channel or less.

6. SOLAR POWER FOR BASE STATIONS

Rural radio telephone base station equipment may also be suitable for solar power if the average current requirements can be supported by a photovoltaics system with adequate reserve for periods without sunshine. Current budget criteria must include factoring consumption at both idle and peak load conditions, and determining average daily power consumption based on loading factors.

Geographic location is an important factor, even within a small political region. Differences in average daily sunlight that would be insignificant in sizing solar power for a subscriber station, with daily usage of only 50-60 watts, become critical to a base station with daily consumption of hundreds of watts. For example, solar powered installations on the cloudy side of Hawaii require twice the solar generating capacity than on the windward side.

Given the importance of properly sizing solar power systems for base station applications, it is strongly suggested that professionals in alternative energy familiar with the region where the equipment is to be installed assistant in the design of the system.

7. RADIO APPLICATIONS WITH UNRELIABLE MAINS POWER

Another common occurrence when installing rural radio telephone equipment in developing regions is that even with grid power available, the power reliability is less than desired for telephone network reliability. Examples of unreliable power include fluctuations in voltage, frequency, and planned or unplanned outages. A system designer can work around inherent power unreliability if system components are designed to accept wide variances in AC power, and supplied with integral backup batteries adequate to carry operations through outages.

7.1 SUBSCRIBER RADIO OPERATION

Certain subscriber station installations for Philippine Long Distance Telephone Company (PLDT) in Manila (where grid power has been interrupted by outages for several hours each day) required unusual power considerations. Subscriber radios were being used at public calling stations where traffic was nearly continuous. The power budget had to support transmit loads throughout the outage times, sometimes 4-6 hours daily. The radio equipment used by PLDT operated on 12 VDC and was very tolerant of fluctuations and hum on its power source. Inexpensive, external automotive-type batteries and chargers were specified, rather than an expensive commercial grade battery plant for each site. These batteries would ordinarily be unsuitable for communications use, as frequent monitoring of electrolyte levels is required, but they could be used in these attended calling stations. More than US$1000 per site was saved and capacity for extended operation without power was retained.

7.2 BASE STATION OPERATION

Often unreliable power can affect not just subscriber equipment, but also base station installations. The common solution has been the use of a fossil fuel generator as a backup. Both the cost of the generating equipment, and the necessary regular maintenance of the installation can affect radio telephone installations. If system capacity requirements allow an analog trunked FM system to be used, these systems can be backed up by internal batteries to allow operation when mains power fails, even if the failures last several hours each day.

8. CONCLUSION

Rural telephone service is a vital component to economic development. Traditionally, radio telephone service has depended upon established, reliable grid power. However, with proper system planning and engineering, full-service wireless telephony can be installed ahead of grid power, accelerating a community's development timetable.

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COMPETITIVE INTELLIGENCE GATHERING

A TELECOMMUNICATIONS NIGHTMARE

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1.0 ABSTRACT

In the past years we have seen an exponential increase in the number of reported claims of industrial or corporate espionage. Most of these claims involved the suspected theft of information rather than goods or equipment. During this same period we have witnessed a change in the modus operandi of most intelligence agencies from an emphasis on acquiring military information to one of acquiring commercial information --especially that information flowing over communications mediums. Given the above, what can and should telecommunications carriers and their corporate customers do to thwart this new threat and protect each other's fragile assets?

2.0 THE SITUATION TODAY

Now that the Cold War has completed its wind down, world governments have significantly de-emphasize the military mission of their intelligence agencies and looked around for new uses for their intelligence capabilities. Many of the agencies whose basic job is to gather information work together on important worldwide efforts such as tracing drug traffickers, minimizing terrorist activities, and exposing those things that are distasteful to all peoples, but such efforts still leave many agents with too little to do.

In the past three years, we have seen a substantial increase in the number of reports of industrial or corporate espionage. Most claims involve the suspected theft of information rather than goods or equipment. At the same time, many intelligence agencies are shrinking or restructuring (like the KGB) and a few—such as the East German Stasi—have disbanded.

We can still presume that virtually every country in the world is spying on every other country. As the need for war-related intelligence gathering declines, agencies are left with more resources to put to gathering commercial intelligence that will give their nation's businesses a competitive advantage. In addition, thousands of former government intelligence agents whose original mission has collapsed are scrambling to find employment. (For example, the Stasi used to have 4,000 agents, many of whom are now are trying to sell their services as independents.) The normal medium for transmission of the stolen information is telecommunications lines. Some information is hand carried, but much of it is encrypted or, unbelievably and boldly, sent in the clear. But while all this is going on, corporate telecommunications and information security managers are generally busy with standard security problems. Also, few corporate security programs are structured to cope with such an extensively well-organized and well-funded threat. Most of the world's telecommunications carriers believe they are powerless to address the problem.

In the face of these changes, we need to define the extent of the threat to our corporations and to our telecommunications infrastructure. We need to identify what roles we should play as corporate managers looking after risk management, telecommunications, physical and information security, contingency planning, or business continuity/disaster recovery and what we need to do to give top management the ability to meet their standard of due-care.

Discussions with many top companies have shown that most senior managers have no idea that business espionage is a serious problem—they especially resist the idea that it is enough of a problem to need action. In many cases, where senior management is advised that their company needs to start encrypting their critical data so that it can't be stolen through interception of microwave or long-line transmission, they say "but we don't have that in our budget." Under the legal principle of due care, however, which guides how a prudent management should act to properly protect its corporate assets, a real risk requires a real and appropriate response regardless of budget.

The first step, then, is to decide whether or not the risk is real. If you believe it is, the next step is to perform a risk assessment. From that, you can determine what the company will have to budget to prevent critical information from getting into the wrong hands.

The crux of the problem is that some information gathered as part of normal intelligence-gathering operations of government intelligence agencies is being sold to the highest bidder. If an intelligence agency captures information from Company A's unprotected phone call, E-mail, cellular phone, or brief case, that information is likely to be sold to one or more of Company A's competitors. Some countries, however, have political infrastructures that make for a more level playing field. For instance, the U.S. and Germany have a tradition of separating government from business that may reduce the risk that companies in the United States or Germany will be victimized to the same extent as those in other countries by the practice of competitive-intelligence "sharing," but it does not remove it. (The United States also appears to exert more control over it's intelligence agency actions than most countries in other parts of the world, but that does not prevent U.S. intelligence agencies from occasionally doing things of which most of us disapprove.)

We do not know what the major intelligence-gathering agencies such as the CIA, Scotland Yard Special Branch, or the CIS would do if they came upon useful corporate information, but it seems doubtful that all would do the same thing. If a Korean intelligence service found out something economically significant and critically important about an overseas company that would give a competitive advantage to a Korean company, would the agency tell that Korean company about that information? Would we want them to? Presumably, should this intelligence-mentality become a common and acceptable practice—a possibility the U.S. Congress is currently debating—agencies would develop a way to decide which competitive companies to approach. But how would an agency decide whether the information it had was valuable enough to try to sell?.

Can you take the chance that this problem won't affect your company? Could any of your company's worldwide operations be a potential target as well? Are your company's communications media and data processing adequately protected? Do your telecommunications carriers offer any help --- or even care?

3.0 WHAT KEY INTELLIGENCE PERSONNEL SAY

Prior to October 1991, the KGB had been involved in gathering competitive intelligence for many years. Its strategy was to leapfrog off stolen western technology. The alleged result of this strategy was to acquire billions of dollars worth of western technology and save hundreds of millions of dollars in their own research and development costs. In October 1991, however, the KGB was disestablished by the USSR. The most powerful First Directorate which specialized in foreign intelligence, was made an independent agency by Mikhail Gorbachev and renamed the Central Intelligence Service (CIS). The new Russia assumed control of former USSR government agencies and many of the newly formed Republics indicated that they would form their own security services. In a short few months the world saw the demise of the USSR and the dissolution of the KGB into several organizations. Many of the specialized services of these organizations are being used by some of the Republics, and many of the ex-KGB personnel who were laid off during the coup, have been hired by the Republics as they develop their own security services. Does all this redirection and decentralization mean that we can stop worrying about the foreign competitive intelligence gathering mission of the former KGB which has been transferred to the CIS?

We can speculate the CIS and individual Republic security services will need to continue to be major players in commercial espionage. Although the Soviet Republics are experiencing serious economic and political trouble and need to generate favorable publicity to attract trade and economic assistance from other countries, it appears that Russian spy rings are still active. For instance, in April 1992 Belgium reportedly uncovered a Russian spy network that was accused of supplying Moscow with information of military use. Belgium warned that the incident could jeopardize the West's commitment to a large aid package for Russia. Belgium Foreign Minister Willy Claes was quoted as saying, "We believed, perhaps a bit naively, that certain practices which belonged to another regime didn't exist any more. I have the impression, I even have the conviction, that the current regime doesn't control all instruments of power."

In the absence of evidence to the contrary, we should be prudent and presume that, as with any nation, old habits die slowly. We still need answers to the following questions:

- New political entities will need the same services-but who will control intelligence activities?

- Thousands of trained agents are now unemployed-how many will freelance?

- Old Party controls are being dismantled-how effective will new political controls be?

- Economic collection ability remains strong and new Republics need the revenue-to what lengths will they go to get it?

The bottom line seems to indicate that the old KGB threat still remains and, unfortunately, may be more unpredictable than ever.

Robert Gates, the former U.S. Director of the Central Intelligence Agency (CIA) gave recent testimony to the House of Representatives Committee on the Judiciary, where he stated: "Essentially, the CIA has three broad tasks with respect to economic issues. One of those tasks is to undertake counterintelligence measures as necessary to protect our economy from those who do not play by the rules. Let me emphasize here that CIA does not and will not engage in commercial espionage. We do not penetrate foreign companies for the purpose of collecting business information of interest to U.S. corporations. It is the role of U.S. business to size up foreign competitors' trade secrets, market strategies, and bid proposals. But we do operate overseas to monitor foreign government-sponsored targeting of American businesses." The CIA recently established a separate division (a fifth directorate) for planning and coordination that will monitor international economic competitiveness and its effect on U.S. national security. Director Gates also clarified what the CIA does with the information it gathers on foreign economic espionage. Gates stated that, "....in coordination with the FBI we inform an individual company if we detect and intelligence operation directed specifically against it overseas. In all such cases, we take care to protect sources and methods. This sometimes required that the information be provided in a generic fashion, but we usually find a way to tell the company what it needs to know to take corrective action." It should be noted that no telecommunications carrier openly offers such assistance to its customers.

William Sessions, former Director of the Federal Bureau of Investigation (FBI) also testified on April 29, 1992 as to the role of the FBI and economic espionage. Mr. Sessions described the February 1, 1992 FBI implementation of its national security threat list approach to safeguarding U.S. national security in the face of a rapidly changing threat. In addressing the new Soviet threat potential, he stated that, "Defectors from the former soviet union and newly independent Russia have openly predicted that the new independent states will escalate industrial espionage activities in the years ahead to bolster their economies and foster increased technological progress. Defectors have stated that the new Russian intelligence service will target the increasing number of U.S./Russian joint business ventures in an effort to steal highly desirable Western technology."

Dr. James Hearn, Deputy Director for Information Systems Security for the National Security Agency (NSA) in his recent testimony, took a different approach. Dr. Hearn reported that, "All the recent penetrations of unclassified systems studied by NSA, NIST (National Institute for Standards and Technology), and GAO (Government Accounting Office) were shown to result from bad security practices such as poor password management, or failure to correct known operating system flaws or physical security weaknesses. The penetrations were the result of adversaries taking advantage of "low-hanging fruit" and more technology would not have helped in those cases. ......we could make our adversaries' lives much tougher, just by fully employing what (security devices) is now available." Dr. Hearn did not discuss a statement last year by Admiral William Studeman, former Director of NSA, which indicated that "NSA will not spy on foreign businesses and give information to American companies. NSA is studying the issue of expanded economic intelligence collection. NSA is willing to help protect economic information, banks, and the Federal treasury from foreign spies." Admiral Studeman's comments were one of the first from a U.S. spy agency saying that it is not going to play this competitive intelligence fame, indicating that it recognizes problems, both legislative and ethical, with the concept of trying to provide economic information to the business sector.

It is interesting to note that virtually nothing has been heard from officials of Russia or the new Soviet Republics on the subject of competitive intelligence gathering, since October 1991. At that time, Yevgeny M. Primakov, the first deputy chairman of the Russian State Security Committee, had publicly stated that he would immediately begin to comply with the decree of the Soviet President to separate the KGB's intelligence-gathering function from its security and counter-espionage function and to emphasize the need for the KGB to demonstrate objectivity and professionalism in fathering and evaluating information abroad. As we will see later in this report, the opposite may be true.

4.0 IDENTIFYING THE PLAYERS

Throughout the past few years, the KGB and GRU, the French DGSE, and Japan appeared to be the most active players in competitive intelligence. However, there are a vast number of intelligence agencies of other nations and independent agents capable of stealing corporate information--indeed, many of them are actively doing just that. During Dr. Hearn's April 29, 1992 questioning after his formal testimony, he indicated that NSA considered the worst offenders as follows: China was described as most aggressive; Russia is becoming more active given their financial situation (though there are still questions regarding the espionage activities of the former USSR satellite states); France is the most notorious; Japan is the most overt and has the "most massive system"; Israel utilizes the most diverse means of spying and will increase its activities as U.S. financial aid declines; Sweden and Switzerland make commercial and financial information a priority; and the United Kingdom is the most successful due to its sophistication and the fact that it is rarely caught.

Any of these agencies would be capable of stealing corporate information---indeed, many of them are actively doing just that---mostly communicating it over telecommunications common carriers.

4.1 The Russian CIS and GRU

The CIS consists primarily of what was the First Directorate of the KGB. The GRU remains the same. Both are clever and well trained in the science of corporate espionage. Their successes in stealing western technology has, by a conservative estimate, saved Russia billions of rubles in military and civilian research and development costs. Evidence presented by Stanislav Levchenko, a former KGB officer, in Congressional testimony on April 29, 1992, stated that part of the role of the CIS continues to be foreign counterintelligence, an effort that has allegedly has not been reduced. Levchenko also reported that, "For decades, political intelligence was the number one (KGB) priority. Now high-tech, industrial, and economic intelligence is the most important priority of the headquarters and of the residencies abroad. The economic situation of Russia and the surrounding states is severe. They do not have the resources nor the time for extensive research and development efforts necessary to compete in international markets. To survive, they will steal the proprietary secrets of foreign companies. Within the last few weeks, France, Belgium, and the Netherlands have broken up industrial espionage rings operating on Moscow's behalf. In my view, these cases reveal increased Russian industrial espionage. It would be naive to hope that President Yeltsin will decide to cut Russian intelligence substantially. In addition, practically all the new countries---the former republics of the USSR---can be expected to conduct external intelligence on their own, with U.S., German, and Japanese technology as a prime target It is prudent to presume that the powers given the KGB in 1991 to carry out unimpeded searches of any foreign or domestic business operating in the then Soviet Union, are still valid and in force in Russia with the CIS. Those powers include the right to enter the premises of any business and seize its records, cash, stocks, and valuables. Companies with operations in Russia should be on alert. Travelers representing target companies in Russia should take particular care with anything they bring into the country. Business papers may be detained in customs; hotel rooms are regularly searched. Restaurants, hotel lobbies, phone, and conference rooms should be assumed to be bugged.

Unfortunately, most of us simplify the work of intelligence agencies by giving them easy access to vital information and simple ways to transmit it. Most commercial data that is unclassified by company-sensitive is stored in clear text formats rather than encrypted. Whether the data reflects proprietary information related to corporate policy and planning or confidential high-technology research, the information is essentially available for anyone to use if it has not been encrypted. The Soviets have also shown a remarkable ability to extract information through the use of sex, bribes, deception, burglary, and theft. They are very clever and keep lists of ready buyers. There is no reason to believe that the "new" KGB will use a kinder and gentler approach. Although this may change, the CIS has had about 1,000 officers assigned full time to the task of obtaining Western technology—one-third of them are on foreign assignments and are outside the confines of the USSR at any given time.

The Russians have also used their allies to help with corporate and technological spying. For example, at about the time of the 1963 Cuban Missile Crisis, Russia established Lourdes, a large listening post in Cuba. By itself, that one listening post has enough technical capability to record practically every long-distance telephone conversation, microwave transmission, and the like from the bottom third of the United States. Thanks to all the communications satellites, the Lourdes facility can listen to message transmissions throughout the world.

Corporate behavior is hard to understand. One would think that companies in a proven danger zone such as in the southern United States would at least be aware of the Lourdes capabilities, but recent discussions with managers of major southern corporations shows otherwise. Many of them are ignorant of the Lourdes operation or and those who do know often do not understand the implications of the Lourdes intercept capabilities. Managers have to make the top corporate level aware that these types of threats are real throughout the world and that they can damage an organization's future.

4.2 The Israelis and the Mossad

The Mossad, or Institute for Intelligence and Special Operations, is one of the most secret intelligence agencies in the world. Much has been written of its exploits over the last five years. Even the Mossad's motto--by way of deception, thou shalt do war--portends the secrecy of its operations. The NSA has just indicated that it expects the Mossad to increase its commercial espionage activities against all countries that reduce their financial aid to Israel. Unlike most other intelligence agencies, the Mossad is small in numbers. A Mossad defector, Victor Ostrovsky, has indicated that the entire Mossad has no more than 1200 employees of which about 40 are case workers or operatives. He said that Israel can tap the "significant and loyal cadre of the worldwide Jewish community outside Israel. This is done through a unique system of volunteer Jewish helpers." The intelligence community quietly considers Israel one of the greatest future commercial espionage threats in the world-particularly if it can utilize the well-placed worldwide Jewish community to gather, what may to any one individual seem to be, an insignificant piece of information.

4.3 Asian Intelligence Agents

Well trained agents from the counties of Vietnam, Korea, and China have been infiltrating the electronic and semi-conductor companies of the free world. The operational mode of these agents is similar to that of the Israelis. Small bits of information are stolen by many different agents and the puzzle is solved by teams in the home country. These agents secure jobs in areas of math, engineering, and science. Many Asians are well trained to do this work and are generally considered excellent employees. These agents use these generalized attributes to gain positions of trust and then accomplish their intelligence missions.

5.0 REALITY CHECK

There have been several widely publicized incidents of the theft and sale of competitive information and hundreds of unpublicized ones. Intelligence agencies from several different countries have caught other intelligence agencies not only stealing information but dealing in stolen information. For example, in 1989 a French news magazine reported that the DGSE recruited spies in Europe to filter the information of such high-tech companies as IBM and Texas Instruments. The DGSE was accused of having spies in the U.S. offices of IBM and TI, and of stealing information left in brief cases in French hotel rooms. Some of this information was allegedly given to Compagnies des Machines Bull, which is also largely owned by the French government. (Bull denied any relationship with the DGSE.) FBI and CIA teams went to Paris, informed the French government that the scheme had been uncovered, and the moles or spies were promptly fired from the U.S. companies.

The U.S. charged that the spy ring was a part of a major espionage program run by Service 7. We know that Service 7 routinely intercepts these kinds of pieces of information. When the investigation was completed, Service 7 admitted to conducting 10 to 15 break-ins every day at large hotels in Paris. Their intelligence gathering teams are well organized. They bring copying machines, cameras, and whatever they need to open the brief case, then they copy the documents and return the briefcase to its original condition. The agents return to their offices to translate the documents, see what is important, and attempt to interest other parties in purchasing the documents.

Another incident involved bugging the seats in Air France business and first class and taping conversations of passengers. Air France is also owned by the French government. Although this incident has received much press, this problem has been known to some of us for the last six years, but no one wanted to believe it existed then. However, it is prudent to assume that other nations also engage in this kind of industrial espionage and support their private industry with it.

6.0 HOW TELECOM INTERCEPTS WORK

Interception of conversations over the direct distance dialing network between two specific individuals in different cities is the most common method used. These interceptions can be made utilizing microwave, multipair signal cables, standard telephone wire taps, video-comline taps, and so on. Technically, the easiest way to capture information is to intercept conversations of people using hand-held radios or walkie-talkies. Radio-telephone intercept, as of cellular phone conversations, is the next-most common method used to acquire or steal significant competitive information. It is possible to gather substantial amounts of business information by listening in on cellular phone conversations, particularly from marketing people. They use cellular telephones while driving because it saves time, but they talk about the wrong things. They talk about competitors, new products, financial results, large orders just landed, and so on.

More sophisticated techniques are used to intercept satellite and microwave transmissions. Communications satellites are typically easy to track and it is relatively simple to home in on one of the satellites that carry commercial information. For example, COMSAT (communications satellite) is a directional intelligence satellite in a geosynchronous orbit 25,000 miles above the earth, and generally over the equator. In a typical international transmission, a microwave communication starts in Country A, goes up to the satellite, is resent, and is received in Country B. However, the transmission can be picked up anywhere by an intelligence agency.

Although we normally think of microwave as a line-of-sight transmission medium, microwave dishes also leak information from their sides and backs. The side and back lobes are areas where interception taps can be installed to capture the information being sent. Unfortunately, some companies think that there is little interception risk as long as they're not in direct line between the sending and receiving microwave stations. The Soviet Consulate in San Francisco, however, made excellent use of back-lobe intercepts and reportedly stole significant amounts of information—most of it transmitted in clear text.

Within the intelligence community, there has been much informed speculation about the tapping of underwater phone lines between North America and other continents. This technology involves using an underwater non intrusive tap signal acquisition. A non intrusive tap and recording device rests somewhere above, but is not attached to, the underwater phone cable. The device would normally be planted and retrieved by submarine. The device reportedly can be as far as 9 miles above the cable and still be effective. To date, however, we know of no confirmed reports of successful use of this technique, and glass fiber cable has made this tapping method much more difficult, but certainly not impossible.

7.0 AMELIORATING THE PROBLEM

First, governments can ensure that business leaders understand the threat to their confidential information. The U.S. Department of State, for one, is holding awareness programs for businesses to communicate some of this information. Also, a few of us give specialized, private briefings to individual companies. As early as 1980, the NSA began a then-secret program in which select executives were invited to briefings where they were told what foreign intelligence agencies were stealing their data. In an attempt to put the seriousness of the problem into perspective, a former NSA staffer said that, "If business leaders could see some of those intelligence reports, they would go bananas and put a lot more effort into protecting their communications". The French, in particular, have been ruthless and consistent in helping their French-owned companies win big electronics and aerospace contracts against bidders from other countries.

Second, most worldwide companies could protect their sensitive communications simply by sending them encoded or encrypted. We have found most companies reluctant to do this even where the cost and inconvenience might be minor compared to the risk of intercept by a competitor. An intelligence agency staff member recently said "companies must realize that they're up against the whole intelligence apparatus of other countries—and they're getting their clocks cleaned." Many vendors are working to build scrambling and encryption devices that are both economically feasible to install and fast enough in interpretation of encryption and decryption that companies can start using them in large-volume operations.

Third, telecommunications companies can minimize cooperating with intelligence agencies when it comes to supporting and adopting specialized encryption schemes, such as AT&T has done with the Capstone and Clipper encryption chips.

Fourth, each company can perform a business impact analysis or risk assessment of its exposure and vulnerability to this kind of competitive intelligence gathering. Each one of us can take a look at a phase of our company's operation and say "are we doing anything that could compromise the company and, if we are, what is the risk? what is the total exposure? what is the annual loss exposure?" Those are things that we can quantify as well as qualify; furthermore, we can use them to develop a proactive plan to keep the company's risk at an acceptable level. Once you know that your information assets are vulnerable to theft or interception, you may—depending on your position in the company—have a legal responsibility to address the issue and see if it affects the company's viability. If you do nothing, you may be liable to a charge of not exercising "due care." Due care is a legal principle that measures what you have done to protect your company's assets in comparison with what another company of like size and complexity has done.

Fifth, companies should attempt to gather competitive intelligence on themselves to learn their own strengths and weaknesses. This knowledge is very valuable in developing an internal plan to control and protect proprietary information.

Sixth, your company can prepare a training plan to educate employees about the potential threat. This plan should tell the employees what their responsibilities are and what actions they would be expected to take in various circumstances. The plan should also give employees the acceptable standards of behavior and, as such, would become a guideline for prosecutable actions.

Seventh, companies and their telecommunications carriers can work more closely together to determine major communications weaknesses and vulnerabilities. We have seen this work well in the case of toll fraud, but we have not seen this spirit of cooperation yet in protection of corporate assets from theft through illegal or illicit use of telecommunication mediums.

Finally, each organization has to consider the "ethics" of employee loyalty to multinational employers and, where these employees are also citizens, to national governments. Companies that have international entities must continually remember that the rules by which the game is played outside of their home base may not be the same. Clearly, if companies want to protect sensitive information, they are going to have to look at scrambling, encrypting, using phone discretion and being much more discrete in how they use fax, e-mail, voice mail, and cellular phones. If the companies of the world don't use protection, they risk losing to the competition in ways they never expected. The problems are not insurmountable as long as we realize that there are methodologies either available or in development that will help mitigate the technical problems. Common sense will dictate what should and should not be said in clear text.

8.0 STANDARDS OF ACCEPTABLE BEHAVIOR

It is the accepted role of intelligence agencies throughout the world to gather intelligence information. It is how they go about it and what they do with the information after they analyze it that can hurt. Too often, the behavioral issues of right and wrong, ethical and unethical, depend on whether one is victim or perpetrator. Now we have new players in the intelligence field: agencies seeking to help their nation's industries, companies seeking a competitive advantage. We can and must set standards of acceptable practice for the gathering of competitive intelligence by the commercial organizations of the world, even if we cannot do so for the intelligence agencies of their governments.

I suggest that it is **ethical** to gather competitive intelligence by:

- Listening to the conversations of others in public places.

- Using any publicly available information about competitors to draw up intelligence profiles

- Directing salespeople, foreign offices, and others to be alert to any news stories, rumors, new product announcements, contract awards, test marketing programs, new advertising programs, and the like that might clarify activities and plans of competitors.

- Eavesdropping electronically on conversations of others in public places.

- Buying products of a competitor for testing, analysis, and review.

- Encouraging employees and their families to participate in consumer non confidential survey programs in which information may be obtained about competitors.

- Taking public tours of a competitor's facilities if the name of your company is divulged properly to host companies if requested.

- Having local salesman drive by or fly over a competitor's facility periodically to note any significant changes.

- Returning documents or computer media marked, known to be or suspected to be confidential to others.

- Contracting for analyses of competitors through ethical consulting firms.

- Publicizing acceptable codes of conduct for employees and penalizing improper practices.

- Reporting suspected espionage activities to victim companies and cooperate in stopping such activities.

- Eavesdropping on employees' communications using company facilities, e.g. E-mail for significant suspicion of specific wrongdoing after having given general due notice to all employees.

I suggest that the following constitute **unethical** behavior:

- Seeking the covert aid of government intelligence services or condoning the use of such covert services for obtaining information on foreign competitors.

- Interviewing applicants to, or hiring employees of competitors for the sole purpose of learning secrets of competitors.

- Emulating the unethical practices of competitors or condoning the use of such practices as "necessary under the circumstances."

- Engaging in, or hiring others to engage in, or condoning any of the following practices aimed at finding more information about competitors:

  – Trash analysis

  – Computer hacking

  – Planting hidden microphones, bugs, etc., tapping communications lines.

  – Touring a competitor's facilities under an assumed name or affiliation.

  – Arranging for spies on competitor's property.

  – Offering compensation or favors in exchange for competitor's secret information.

  – Accepting and using secret or suspected secret information about a competitor from disgruntled employees or from anonymous sources, or failing to report such overtures to the competitor.

  – Requesting or accepting secret or suspected secret information from advertising agencies or other mutual suppliers about new campaigns, products, or plans of competitors.

  – Taking advantage of an emergency to learn secret information about a competitor.

  – Using foreign offices of companies to covertly gather intelligence information for government intelligence agencies.

  – Using documents or computer media marked known to be—or suspected of being—confidential to others.

Whatever you decide in terms of corporate intelligence gathering, however, it is important to recognize that the world has changed and that the international change to a heavy use of telecommunications mediums as the source of or as the main conduit for the transmission of the gathered intelligence will—one way or another—affect your company's bottom line.

9.0 SUMMARY

Recent history tells us that foreign business espionage threats are real and many of these threats are state supported. The concept of ethical or "fair play" differs from country to country. We must all attempt to learn the culture differences in any country in which we do business. The world-wide dependence on all types of technology makes many countries more vulnerable that others. Clearly, awareness is our best human protection; encryption is our best technical protection; and, common sense is our best overall protection.

Commercial espionage is becoming a much more clandestined and serious threat to the viability of many international organizations. Traditional security and asset protection approaches are usually proving inadequate in stopping this espionage. Yet, "due care" demands that corporate management take corrective action. Your company's survival may depend on quick and decisive actions that have been planned and rehearsed. This could mean that corporations may need to reassess their policies towards cooperation with intelligence agencies throughout the world. Could this also mean the beginning of a new working relationship between corporations and their telecommunications carriers? I hope so because with this new spirit of cooperation, its a win/win proposition for the intended victims.

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THE AUSTRALIAN REVIEW INTO WIRELESS PERSONAL COMMUNICATIONS SERVICES

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1. ABSTRACT

Wireless Personal Communications Services, a subset of personal communications services generall, will emerge as existing and future technologies are brought together to provide the ability to communicate anywhere, at any time, with anyone or anything, according to individual needs. This paper provides a summary of the Australian inquiry into Wireless Personal Communications Services.

2. BACKGROUND

In November 1992, the Minister for Transport and Communications requested AUSTEL, the Australian Telecommunications Authority, to conduct an investigation into emerging technologies for the delivery of wireless personal communications services (PCS). The purpose of the investigation was:

- to inform the Government on the issues surrounding marketplace developments in this field that could have implications for future mobile communications services in Australia, and
- to ensure that the relevant policy measures continue to provide for the orderly extension of wireless communications services on a commercial basis within the established regulatory framework as new technologies become available.

Within the context of Government policy relating to the licensing of Public Mobile Telephone Service (PMTS) carriers and Public Access Cordless Telephone Service (PACTS) providers, and having regard to the Government's radio communications spectrum pricing and management arrangements, AUSTEL was asked to report on:

- developments in new wireless technologies with implications for the delivery of PACTS, PMTS or PCS in Australia, or that would allow migration from existing technologies to PCS in the future;
- criteria that could apply, within the telecommunications and radio communications standards and regulatory framework in setting appropriate technical standards for use in Australia;
- spectrum requirements for PCS; and
- other matters that AUSTEL considered relevant.

AUSTEL was also asked to consult widely with the industry and users to solicit their views on the possible development of PCS and related services in the future and to specifically address the following matters:

- possible characteristics of PCS;
- factors that are likely to influence PCS demand and industry growth;
- readiness or maturity of prospective technologies in terms of standardisation and industrialisation;
- technical considerations and spectrum requirements related to the possible provision of PCS in Australia, including:
  - — compatibility with existing mobile communications standards, ie complementarity with cordless and cellular technology
  - — extent to which existing cordless, cellular and future technologies provide evolutionary paths to possible future PCS, including satellite components such as low earth orbiting satellites (LEOS);

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- implications of possible future PCS for
  - consumers
  - existing or yet to be licensed cordless/cellular providers
  - availability of equipment in Australia
  - telecommunications networks
  - telephone numbering, and

- any other pertinent issues

AUSTEL'S Approach

In order to encourage broad public participation, AUSTEL prepared a discussion paper which was widely circulated during January 1993 and promoted by way of a media release and through national, metropolitan and major regional newspapers. In addition, several organisations in Australia and overseas were invited to contribute directly or through the Standards Advisory Committee and the Australian CCITT Committee, both of which are convened and chaired by AUSTEL. Since most of the attention in Australia for the previous two years had been focussed on the introduction of digital GSM mobile services, AUSTEL's primary challenge was to encourage the widest range of views, uninhibited by the immediate circumstances.

AUSTEL also held public seminars to discuss the preliminary findings and to encourage further feedback, and to assist in finalising its report to the Minister.

3. SUMMARY OF FINDINGS

Characteristics of Wireless PCS

The current demand for existing analogue cellular services indicates that the trend away from fixed telecommunications services towards a greater use of mobile communications is rapidly increasing. Cellular growth in Australia, for example, is estimated at 20,000 new customers per month, most of whom utilise hand portables. While this trend was initially for business customers, there is a growing number of social and residential customers taking up the service.

Increased global competition and the consequent drive for lower costs have stimulated advances in radio systems engineering, digital signal processing, satellite technology, switching capabilities, computers, microelectronics and integrated circuit engineering and software, which in turn facilitate Wireless PCS and feed the global interest in and emergence of PCS.

The development of most telecommunications services, with the possible exception of the standard telephone service (or POTS) has been characterised by a technology-led approach aimed at specific market sectors. Although the needs and desires of users have received some consideration, the availability and format of services have been determined mostly in accordance with the business directions and priorities of the carriers and service providers. The development and introduction of ISDN, at least in Australia, is one example of a technology-led approach which resulted in a long period of intensive and expensive marketing effort in order to identify and implement genuine user applications.

PCS offers the promise of a new approach to planning service provision, in which the customer has a high degree of control over the service features and availability. This customer focus then sets the conditions for considerations of technology and of the licensing and regulatory regimes, rather than the other way around. This approach recognises the expectation that PCS is likely to become a mass market service in much the same way as the standard telephone service.

Concept and definition

The concept of PCS is, to some extent, still emerging, but it can be considered in terms of two components, ***personal communications*** and ***personal services***. Personal communications places the emphasis on communications between people rather than between terminals or equipment and implies access to telecommunications networks. Personal services implies an emphasis on service features and availability tailored to the specific needs of the individual. Personal services are intimately dependent upon network intelligence.

The optimum realisation of PCS relies upon the seamless integration of existing and emerging technologies and services across fixed and wireless networks, both public and private. Wireless PCS, as part of this broader context recognises the use of wireless access at one or both ends of a service connection. It promises to provide customers with greater control over their services with the ability to access services and service features which match and enhance individual lifestyles.

The most commonly used definition of PCS and that accepted by AUSTEL is:

> ***"the ability to communicate anywhere, at any time, with anyone or anything, according to individual needs."***

Implications

Most wireless-based developments to date, including cellular, cordless, private mobile radio and paging, have been complementary to the fixed network with only a minor impact on its infrastructure or the services deployed on it. PCS with its inherent mobility, flexibility and convergence of technologies and services, introduces the potential to both complement and compete with the fixed network. The increased network intelligence will bring with it a greater synergy between fixed and wireless networks and between private and public networks.

The new synergies will create new challenges for the regulatory framework. The maintenance of a technology neutral policy approach, to the extent possible, and regulation of service provision is logically more sustainable. It is essential that decisions on telecommunications policy focus on **services** not the **technologies** employed. To do otherwise entails an attempt to pick technology winners and loser - a process fraught with risk, as technological change and development do not respect boundaries imposed by policy makers and regulators.

The adoption of appropriate technical standards will therefore continue to be the cornerstone of successful service introduction and development. The new manufacturing and service opportunities created by the introduction of PCS will be greatly enhanced in the marketplace if global or regional standardisation is pursued. Within the ITU, the Standardization Sector is studying the concept of a unique personal number (UPT) by which services are accessed and enabled and the Standardization and Radio communications Sectors are studying the Future Public Land Mobile Telecommunication Systems (FPLMTS) with a view to integrating cellular, cordless, satellite, paging systems and fixed network platforms.

If standards issues are not handled effectively, there could be an impediment to the development of a mass consumer market for Wireless PCS.

Development and Licensing

Existing cellular operators have signalled an intention to introduce PCS to focus on a wider market than traditional cellular. The achievement of economies of scale is critical to the success of PCS, such that the services can be provided economically to the ultimate end user. Perhaps the greatest challenge facing potential PCS providers is the achievement of access and usage charges which will make PCS a mass market development.

Since Australia is a relatively small market, this mitigates against the adoption of multiple technology choices for PCS and steers the Government towards a balanced view in terms of technologically neutrality. Thus the number of component standards is limited for each class of technology, barring the development of a grand unified standard. This contrasts with countries like the USA, for example, where a laissez faire approach can allow for the introduction of a large number of standards or specifications with the expectation that the market forces will prevail to enable the most viable to survive.

Australian operators, manufacturers and users generally came to the same conclusion in relation to the most appropriate standards to meet each of the identified requirements, while recognising the importance of choosing a migratory path which is compatible with the emergence of the ITU's FPLMTS concept. The proposed standards map, which builds on the existing and emerging standards platform, is as follows:

COVERAGE	**STANDARD**
National	Satellite system (megacellular) - Not yet determined
Land Mobile (high speed vehicular)	GSM 900 (cellular)
General outdoor	DCS 1800 (macro cellular)
Indoor/office	DECT (micro cellular)

Emerging and future developments of air interfaces, such as CDMA, are not excluded by the development of consistent and compatible standards since they may attach to the platform as the technologies prove themselves out.

Currently, there are two licensed general carriers, Telecom and Optus, and three licensed mobile carriers, Telecom, Optus and Vodafone. There is potential for this licensing regime to inhibit potential providers of Wireless PCS in their ability to exploit all or any of the available technologies. For example, the line link reservations in the Telecommunications Act 1991 preclude persons other than Telecom or Optus from providing the fixed network backbone for Wireless PCS or from providing satellite services, other than through resale. These and other issues should be examined in the Government's planned review into arrangements which should apply after 1997.

Spectrum Provision

The availability of adequate and appropriate spectrum is one of the most critical factors in enabling Wireless PCS. AUSTEL recognised that in the setting of technical standards for Wireless PCS, consideration must be given to international standards and the availability of spectrum, since it is these standards and their underlying technologies which will determine the spectrum requirements.

Most of the emerging and future Wireless PCS standards to be considered for Australia will occupy spectrum between 1700 and 2300 MHz. A number of key issues became apparent in relation to allocations for Wireless PCS.

The first of these is the amount of spectrum within the overall range which will satisfy Australia's requirements and those of regional or international roaming. For example, while the overall population of Australia may be low in comparison with many countries and this suggests a lower spectrum requirement, the urban areas often exhibit very similar population densities.

Secondly, the timing of spectrum availability for particular technologies may be critical for investment and marketing decisions.

Thirdly, it is necessary to consider what arrangement are appropriate to accommodate existing and future technologies and requirements, while at the same time prepare a migratory path to future world wide allocations.

Finally, all of these issues need to recognise the legitimate and often competing interests of existing services which may currently occupy spectrum or be denied access in future.

A new system of licensing the use of spectrum in Australia, provided for in the Radio communications Act 1992, is being implemented by the Spectrum Management Agency. This system introduces three types of licences: apparatus licences; class licences; and spectrum licences.

Apparatus licences, similar to existing radio communications licences, will be subject to an administrative licensing process where spectrum is designated for specified apparatus or equipment. A class licence will authorise specified radio communications services or equipment, such as low powered devices, to use spectrum in accordance with terms and conditions of that licence. Spectrum licences will involve a market based approach to the issue and use of spectrum, whereby licence holders will be free to use their spectrum in a flexible manner and my trade the licences at will.

This new market approach to spectrum management is intended to facilitate faster access to spectrum and hence enable the rapid deployment of new services.

Numbering

In order for PCS to deliver the promised benefits, the national numbering system must be able to support the inherent characteristics of the PCS platform and provide adequate capacity for future Wireless PCS offerings.

These issues were considered in the context of the inquiry and related back to the discussions occurring through AUSTEL's Numbering Advisory Committee, which was considering the overall aspects of the numbering requirements for Australia's telecommunications services. In the main, numbers will be allocated on a pro-competitive and equitable basis from the ranges set aside for the type of service category with which the service is associated. Several service categories, including UPT numbering have been set aside in the new numbering plan.

Electromagnetic Compatibility and Bio-Hazards

The issues of unintentional interference and effects on human beings have become of wide concern in this age of proliferation of radio products and services. Wireless PCS and its potential to become a mass market service should proceed only when these issues have been fully addressed. In the course of AUSTEL's inquiry, concerns were raised in the areas of general equipment immunity, interference to hearing aids, body worn and implanted therapeutic devices and safety critical systems, together with electro-explosive hazards and biological hazards.

The Government has established a working group to examine these issues in greater detail, in relation to the broad range of radio communications services and devices, which will include the Wireless PCS offerings.

Other issues

Some other issues canvassed in the AUSTEL inquiry included privacy and interception. Both of these issues, while covered to some extent by the inquiry are the subject of other working groups or inquiries.

COMMUNICATION ETHICS AND THE PACIFIC CULTURES: IN WHOSE IMAGE?

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1. ABSTRACT

Three primary definitions of ethics are 1)a way of life (e.g. the Judeo-Christian ethic, the Buddhist ethic, the Maori ethic, etc.) 2) codes, policies, and norms of personal or professional conduct, and 3) the **study of** #1 and #2, as in philosophy. Problems in understanding ethics in Pacific cultures may arise from confusing these types of definition.
To indegenous peoples, their overarching ethic (singular) may be inseparable from a spiritual, environmentally integrated way of life. More recently established Pacific subcultures, including those fostering telecommumnications networks, may frequently utilize definition #2, and view ethics (plural) as a parade of fragmented issues, such as privacy, piracy. obscenity, and libel. Another Pacific group or subculture, the scholars who study and teach definiton #3, can help understand the relationship between the first two definitions at a time when communication technologies and the ethical issues surrounding them rapidly change.

1. Definitions

Of the thousands of definitions of ethics found in dictionaries worldwide, three generic definitions may be synthesized:

1)**ethics:** a way of life, such as the Buddhist, Judeo-Christian, Maori, Tongan, or capitalist ethic.

2)**ethics:** codes, policies, guidelines, and norms declaring right and wrong good and bad, and prescribing personal or professional moral behavior.

3)**ethics:** the formal study of #1 (a way of life) and #2 (codes and norms), as in philosophy.

It should be noted that definition #1 frequently assumes the singular form **ethic**, as in the Muslim, Marxist, or Navaho ethic, suggesting a single, over-arching fabric of belief or lifestyle. Conversely, definition #2, confirms the plural form **ethics**, suggesting a fragmented series of issues or rules, as in a code of ethics.

2.Telecommunication Ethics

Those who originally perceived that telecommunication would create ethical issues were usually from the professional, business, and institutional sectors of industrialized societies. Thus it is not uncommon to discover that discussions of telecommunication ethics are often structured according to specific Western nomenclature, such as privacy, piracy, copywright, libel, confidentiality and obscenity. For example, some papers presented at the Pacific Telecommunications Council of 1993 were entitled "Caller ID and Privacy" by Peter White, "Managing the Privacy Implications of New Technologies" by Brian Milton, "Software Patents, Ownership, and Infringement Crimes:New Developments" by Steven Glazier, and "The Personal Data Protection Regime Emerging in Korea" by Jisuk Woo.(1)

Such literature is indirectly imbedded within the larger Western tradition of treating specific ethical dilemmas as discrete issues. Terms such as "invasion of privacy", "source confidentiality", "freedom of information", "copywright infringement", "first amendment rights", and similar phrases derive primarily from European and American legal and linguistic structures.

3) Pacific Telecommunication Ethics

Pacific communication ethics are far more complex. As early as 1983, when Rahim and Wedemeyer edited **Telecom Pacific**, it was noted that over 10,000 islands and 50 countries comprise the Pacific area encompassed through telecommunication. (2) Many Pacific peoples have neither the concepts nor words for either "communications" or "ethics".

While both cultural and lingustic translation are never exact, it seems more appropriate to say that many non-Westernized Pacific people have traditionally expressed an **ethic** (definition #1). rather than they have established or discussed specific professional **ethics** (definition #2). From an industrialized perspective, such an inherent **ethic** might be called a land ethic, or spiritual ethic, since moral rules are frequently centered within a natural (cf. ecological) or Divine order.

In one sense, each tribe and inhabited island may be said to have its own ethic. Thus it is difficult to discuss Pacific ethics as a universal system or concept, or even as agreed upon set of issues.

4)The Intersection Between Ethics and an Ethic

From the standpoint of definition #3, those who study the ethic/ethics relationship may discover misunderstandings and conflicts between the two approaches. For example, as person immersed in the Judeo-Christian or Buddhist ethic form birth might be taught that killing is unethical (#1) and immoral. However, upon being drafted into the military, the same person might be told that **failure** to kill an invading enemy soldiers by deserting one's colleagues violates a military code (#2). On the other hand, killing an enemy prisoner may be a violation of military ethics (#2). However, letting an enemy prisoner die of starvation in order to feed one's own troops may not be such a violation.

In short there may be contradictions between one's ethic (#1) and one's ethics (#2), and there may be contradictions **within** one's ethic or one's ethics. Such problems are compounded when more than one **ethic** is combined, such as in Pacific countries in which numerous cultures co-exist.

5) Example of the ethic/ethics phenomenon in Majuro, Kuror, and Yap

Innumerable examples of tension between conflicting ethical systems exist worldwide. Within the Middle East, various parties in numerous conflicts have claimed higher ethical ground than their adversaries. The ongoing war in Northern Ireland, (Ulster), is not only between two different religous and political views, but between their differing ethical claims.

Similarly, telecommunication-inspired tensions in the Pacific may require understanding an ethic (#1) in conflict with ethics (#20, or understanding differing ethical (#3) systems, or both.

Consider for example Michael Ogden's report about his fieldwork conducted in 1990 in the Republic of the Marshall Islands and the Republic of Palau. In his paper, "Preliminary Report on the Social Impact of Television in Palau and the Marshall Islands", Ogden wrote:

> Since most people in both societies do not speak English, the younger people must translate the televised stories for their grandparents. This reverses the traditional flow of information--instead of the old passing on the information to the young, the communication flow is in the opposite direction. As a result of this young people were seen to be discounting (or out-right ignoring) any information passed on from their elders. This disturbed many...and the tradition of respecting elders and a possible catalyst for the potential loss of traditional knowledge due to neglect and its being replaced by mediated information. (3)

The ethics of those bringing television to these two societies have been virtuous within its own terms. Dissemination of knowledge to the information poor, making technology available beyond the elite ranks, connecting isolated people to the global community, may seem virtuous within an egalitarian and distributive justice ethic. Within the Judeo-Christian ethic, those bringing communication may have been "loving their neighbor". Similarly, within the capitalist ethic, those involved my have succeeded by creating new markets and outdistancing competitors due to assiduous, self-sacrificing labor.

However, from an insider's view, "outsider's" ethics may be at best uncomprehending, and at most destructive. If the advent of television is closely linked with the erosion of, for example, the Palaun ethic, as Ogden suggests, a new moral order, such as that seemingly advocated by advertising and commercial programming, may eventually delimit or supplant another.

In the video documentary **YAP...How Did You Know We'd Like TV?** (Direct Cinema,1987), it is similarly noticeable that television introduced both differing ethics and a different ethic than those native to Yap had been taught.(4). Programming broadcast in the United States brought advertising messages such as "remove ungainly ring around the collar" and "make unsightly food stains disappear" to Yap. To many Pacific peoples the earth, from which "dirt" is inseparable, is sacred and a source of origin, and yet television seemed to teach, almost pathologically, that dirtiness, or earthiness, was anti-social, unsanitary , and even ugly.

6) Ethics #3

The branch of philosophy known as ethics (#3) has systematically studied differing approaches to moral questions. One role that the ethicist may play in studying Pacific telecommunication is that of studying and interpreting unique ethical systems. Although ethicists are sometimes viewed as moralists who impose their personal ethics upon society, ethics #3 is not intended to be dogmatic nor self-righteous.

The study of cultural ethics may instead be a means of understanding the value systems beneath differing groups, cultures, and genders as a means of assessing their conflicts, cooperative projects, and overlapping concerns. Cross-cultural ethics may be helpful to groups who fail to appreciate each other's moral universe. In the words of Tom Brislin, "some groups honor more of an upper case "E" ethics and others a lower case "e" ethics." (5) It is important to understand Brislin's meaning, and how such distinctions bring insight.

One step toward understanding Pacific telecommunications ethics is to list and analyze issues as they might be viewed by telecommunication corporations and those who study them. Such issues include, but are not limited to:

1) computer piracy, hacking and secrecy

2) information anxiety, overload, and inaccuracy

3) invasion of privacy

4) noise pollution

5) one way flow of communication

6) spectrum allocation

7) copywright and ownership law

8) conflict of interest

9) defamation, slander, and libel

10) deceptive advertising: fraud, puffery, hype, and distortion

11) indecency, obscenity, and pornography

12) source confidentiality

13) zoning and redlining

14) fairness and equal time in political campaigning

15) free expression, censorship, and right to reply

Similarly, one may identify specific ethical concerns within each, more holistic indigenous ethic. Some of these have been introduced or amplified by the arrival of foreign settlers, such as from the United States, Canada, Russia, and Japan. In reading these, it is important to keep in mind that each word approximates meanings and feelings translated linguistically and perceptually from other mindsets into our language and percepts. Such ethical concerns about Pacific telecommunication phenomena, as felt or voiced by various Pacific peoples, include, but are not limited to:

1) erosion of a traditional way of life (ethic #1)

2) homogenization; increasingly resembling (an)other culture

3) imposition of external rhythms, products and activities

4) economic, military, or cultural dependency upon outsiders

5) reciprocity (if you broadcast to us, why can't we broadcast to you?")

6) monopoly; power control

7) commercialization and consumer values

8) autonomy (no local determination of technology selection and programming)

9) profit exportation; exploitation

10) supplanting of local language with English or Japanese

11) sacrilege; mockery of (the) God(s); increased violence and gratuitous sex

12) destruction and ridicule of nature

13) speed-up

14) invasion of supercial meaning (trends, ads, gimmicks, nostrums)

15) disintegration of family and community

7)Summary

Within the scope of ethics #3, beginning to identify, define, and list the ethical concerns of people creating and people consuming telecommunication systems and messages is a useful first step. Case studies, such as those in Richard Brislin's **CROSS CULTURAL ENCOUNTERS** (Pergamon, 1981), and those populating the mainstream literature of cultural anthropology, are helpful (6). Reading between the lines of books like **TRANSNATIONAL COMMUNICATIONS** (Sage, 1991) which anthologize essays by such scholars as Lent, Sussman, and Pendagar is also instructive (7).

In **COMMUNICATION ETHICS AND GLOBAL CHANGE** (Longman, 1989), twenty scholars from fourteen national backgrounds collaborated to note how communication ethics (and the regulation of mass media) differed in unique social, political, and ethical systems (8). Usually, the prevailing ethic (#1) will strongly condition and modify professional ethics (#2). However, the converse may also be true, as when the ethics codes (#2), or lack of same, are taught by multinational media corporations to their employees and audiences worldwide.

Perhaps the first task before all those--island inhabitants, telecommunications professionals, policy planners, political leaders, scholars, and others--seeking to understand Pacific telecommunication ethics is to pull back from insular perspectives and cultivate respectful understanding of a variety of ethical approaches.

In a pluralistic society, a plurality of moral, often subconscious vectors, will underpin the discomforts and confusion surrounding changing and expanding technology. To assess each ethic on its own terms seems a priori to discerning which ethics (#2) may be confusing, essential, intrusive, destructive, or helpful to particular situations. As the relationships between ethics (#2) and each cultural ethic (#1) change, a more reflective, transcendent, and scholarly ethics (#3) may be useful to provide, compare, and assess the menu of ethical orders.

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3) Ogden, Michael R. "Preliminary Report on the Social Impact of Television in Palau and the Marshall Islands." Pacific Telecommunications Council Thirteenth Annual Conference. Honolulu: Pacific Telecommunications Council, (1991): 845-851.

4) Yap...How Did You Know We'd Like TV? Directed by Dennis O'Rourke. Produced by O'Rourke and Associates, Direct Cinema Limited,1987.

5) Brislin, Thomas. Boston-Honolulu telephone interview. November 10, 1993.

6) Brislin, Richard. Cross Cultural Encounters:Face to Face Interaction. New York:Pergamon Press, 1981.

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Digitized And Mobile Lives: Hypotheses For Discussion

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1. Abstract

Are new telecommunication technologies creating a one-way asynchronous communication society where the primary goal is to convey messages rather than to interact? Will technological advances create unprecedented equity between the visual and aural senses? Will our lives become proportionately less private as the media we use create a greater illusion of privacy? These are some of the questions to be explored in a discussion group at the conference.

2. Introduction

Do you send "confidential" faxes? Did you buy your significant other a pager or cellular phone? Do you use e-mail to keep in touch with family & friends? This discussion group will explore personal insights and incidents that, when combined, may shed some light on emerging patterns and trends in innovative personal uses of new telecommunication technologies.

Are we seeing a change in social standards in the areas of communication privacy in shared spaces? Will there be a permanent double standard in etiquette between mediated communication and face-to-face communication or will one form ultimately adapt to the standards established by the other? Are we beginning to see a change in the way we make sense of visual and aural information? This forum is open to individual viewpoints and a healthy discussion of the author's hypotheses which are shared in the following essay. As D. J. Wennemann has said "...it is not possible to define the realities of freedom and hope. These lie in the realm of the experiential. To define them would be to undermine their historical reality since they have to do with action and not primarily with knowledge." (1) The aim of the discussion group will be to spend a few moments experiencing a shared reality, with an eye toward defining the inherent potential for freedom and hope dormant in new telecommunication technologies.

3. Privatization of The Medium; Deprivatization of The Individual

In the early eighties experiments were taking place in American and British living rooms to get a more objective and scientific perspective on the average family's television viewing habits. Cameras were installed in living rooms that detected movement and form to enable market researchers to tell which family members were leaving the room during the commercial breaks to snack in the kitchen or otherwise avoid the ads; leaving behind the pet as the only viewer sitting on the sofa. When we shared this information with Generation X students at a private business college in Boston, their immediate reaction was one of joy and approval: this was "neat" for the family and beneficial to the marketplace. When asked whether lack of privacy was an issue, the standard reaction was "What's the problem? We have nothing to hide. We are already sharing personal information in dozens of other ways, why single out this experiment?" And so we had comfortably established yet another avenue for the mass marketization of our lives.

A decade later, the institutionalized sharing of private lives is most clearly notable on talk radio and talk television. As the public begins to depend more on cable than broadcast television, many public rights to "community standards" vanish. As we choose to centralize our video rentals through a "video-on-demand" system from a single online source rather than roaming the neighborhoods to pick & choose from a variety of small and large suppliers; as we choose to "rent" our much fancier VCR from the cable company and have it at supplier's side of the system rather than in our own homes; we are echoing the voices of the X-Generation that we have no privacy left to lose. (It is beyond the scope of this discussion to explore the economic implications of the centralized outsourcing of our information needs within the context of our neighbor's right to own a small business that used to provide us with the videos or the VCRs.)

Examples of privacy concerns abound in most strictly (or obviously) computer-based systems such as online databases and computer networks; therefore, the current discussion will focus on other telecommunication technologies; specifically voice mail and telefacsimile systems.

Traditional Etiquette vs. Telespace Etiquette: In most personal or professional relationships to date, we have enjoyed a level of established knowledge about the medium of communication that guides our social etiquette. For example, when we use someone's mailing address, we base our communication content on the full theoretical assurance that a first-class mailing in a sealed envelope will be seen by the addressee and no one else. If we choose to send someone a "confidential" postcard, however, our action speaks for itself. In the pre-voicemail era, if we intended to communicate by telephone, either the responder was the party to whom we wished to speak or we were advised to call back or leave a message.

If we chose to leave a highly personal message through a third party, we would be doing this quite consciously - and thus intentionally. Today, there is ample evidence that highly private messages are being transmitted through not-so-private media. Is this the beginning of a new ethic or a transitory state of naive users?

What about the conscious intentions of those who leave what appear to be confidential messages on potentially shared voice mail, answering machines, or fax machines? Is it simply a temporary misuse of such telecommunication media or is this behavior the equivalent of de-inhibition (flaming), or is it altogether a new phenomenon created by an opportunity that was non-existent under older mediated technologies?

For example, are new telecommunication technologies allowing the more timid members of our society to act out their fantasies? Not everyone who distributes a fax number is likely to have a private line within a secure or private setting. Those who have such devices at home are also likely to be sharing the line with other family members. It has been observed that private information (in the nature of love letters and "hate letters") are freely transmitted over such lines. It has also been noted that some individuals make a habit of reading or reviewing everyone's incoming faxes. Are those responsible for sending faxes actually intending to disseminate such messages beyond the addressee (and are they in fact counting on an interceptor to disseminate the information?) or is this simply a case of sloppy communication or lack of etiquette?

When individuals use new semi-public telecommunication technologies to direct personal and private messages to others, is there a sense of personal absolution and secret comic relief envisioning the recipient of such messages squirming at a distance?

Hypothesis 1: The more privatized the image of a medium and its services, the less privatized our private lives.

4. The One-Way Society, or: Crying into a Vacuum

Last year's participants in a PTC discussion group on the social impact of telecommunication technologies may have come in with diverse views, but we seemed to depart with one common observation: most individuals use telecommunication technologies as a means of control, filtering and minimizing contacts rather than expanding communication opportunities. Joseph Kayany confirms the results in more objective terms: "content control was found to be a significant factor in all situations that were studied. Among the four modes of communication, face-to-face was most used for persuasion, while the other modes were chosen for evading the other. Telephone and e-mail in particular were used to position oneself relationally vis-a-vis the other." (2)

Long before ISDN becomes ubiquitous or the merger of cable and telephone companies confuse our concepts of the underlying functions of various media, the people have voted with their pocketbooks. They want control over their communication and interaction destinies. We are voting for a world of asynchrony, where the ultimate goal may be to send messages out rather than be concerned over the effects of such messages or whether anyone really bothers to respond.

Evidence for this exists in a variety of media: the dozens of cable channels which may or may not have an audience, the dozens of radio talk shows where the host (particularly based on the Rush Limbaugh model) will "pull the plug" on any caller whose views he doesn't appreciate; the multitude of computer network users posting messages seemingly at random; the majority of pager users who depend on this device to filter callers; and those who buy their loved ones pagers - for the ultimate one-way command.

Hypothesis 2: New telecommunication technologies are creating a one-way asynchronous communication society where the primary goal is to convey messages rather than to interact.

Corollary 1: The primary intention of communication is weighted heavily toward the dissemination function rather than the processing and interpretation of messages.

Corollary 2: The communicator's desire to send messages takes undue precedence over the recipient's reactions. ("If you don't like it change the channel; turn it off; tune out...") A communication pattern that used to signify the inequality of a power relationship and some hierarchy of power has been extended to apply to all communication.

Corollary 3: Many new telecommunication technologies provide the communicator with an illusion of power, albeit briefly, by providing a one-way command mode as opposed to a 2-way medium with potential for immediate (and potentially damaging) feedback.

5. "None of the Above" Is Not a Choice

When the issue under discussion takes a turn toward the abstract and intangible, our society is less likely to pay immediate attention to its ramifications or consequences. Our obsession with having a variety of telecommunication devices to choose from - a very tangible state of being - detracts from the ultimate lack of individual freedom to be able to accept or reject the use of some of these technologies in situations of our own choosing.

Some students of "technology" have a tendency to treat societal reactions in one "lump" or to label individuals or groups in broad categories of technophiles, technophobes, or technoneutrals. In reality, individuals and societies don't fall into such neat categories. General observation indicates that technological innovations are far more easily adopted if they do not disrupt the existing value system or when adoption is a matter of personal choice rather than a social or organizational mandate. Witness the penetration rate of some new telecommunication technologies for personal use compared to the adoption rate for personal computers.

Hypothesis 3: Those who are in the forefront of new developments in telecommunication technologies are the most likely to adopt such technologies by personal choice; Their willingness to adopt or adapt is not necessarily extendible to the general population.

6. Equalizing The Impact Of Visual With The Aural

When the input mechanism for both hearing and seeing has been reduced to a binary code and fed into our central processor, is there still a discriminating factor that separates the two at the output end? In other words, the digitized form of all audio, video, and text signals are equally subject to manipulation before or after a telecommunication transmission. Whereas in the past we were warned to be leery of things we read, we are now advised to be leery of the things we see through a telecommunication medium. Where is our current balance of ethical standards for preserving an "objective" view of our world vis a vis our fascination with the "subjective" special effects achievable through electronic communication media?

Hypothesis 4: Technological advances in telecommunication will create equity between the visual and aural senses. This equity will move in the direction of equalizing the validity of the visual cues to the current confidence level in aural signals. All visual and auditory signals will then be highly subject to personal interpretation without the single accepted cloak we presume to impose on the printed word through standardized language dictionaries.

Corollary 1: The well-established cautionary note "Don't believe everything you read" will be modified to "Don't believe everything you sense."

7. Puzzlers Of The Mobile Age

Case of the missing pen turns into the case of the missing computer. The more affluent the society, the less prized are its mundane artifacts. Children of the 1990s don't stop to pick up pennies from the sidewalk; students in affluent neighborhoods abandon jackets, gloves, and umbrellas let alone pencils or pens. Visionaries predict that someday soon we will have throw-away computers because their components will be relatively cheap to make. Yet, even though it has been two decades since gas stations began giving away pocket calculators as prizes, we have not seen a major drop in electronic calculator prices. Therefore, I pose the following questions in the sincere hope that electronic communication experts will resolve the puzzles associated with mobile devices:

(1) As a community, how soon (if ever) will we be able to afford disposable computers and telecommunication devices? Until such time that computer prices come down to match today's cost of a Bic pen, how comfortable will we be leaving such devices behind in public places (or dragging them with us) as we visit public bathrooms, beach parks, or the train's dining car? In other words, as portable as these telecommunication devices may be weight-wise, how portable are they likely to be cost-wise?

(2) Our society resolved monetary issues related to the loss of credit cards by limiting the consumer's liability and making the credit agency primarily responsible for the consequences of loss or theft. In turn, the cost of taking such risks was indirectly passed back to the consumer. What will be the equivalent of this in the portable electronics market? As it stands, the cellular telephone and pager companies subsidize the cost of the telephone through subscription agreements. However, if the device is lost or stolen, not only is it not replaced by the company, but the subscriber must continue to pay the monthly subscription for a service that can no longer be used.

(3) Given the current limits of the power supply on truly portable devices, can they be used for anything other than emergency assignments, or - regardless of their true portable weight - are they tied down to the car battery that is attached to a 3000 pound car? Some may argue that the car itself is mobile; but when product developers are vying for our dollars based on "ounces" of difference among products, this seems like a fair question. During the last several months of carrying a Powerbook with me, I have come to the realization that it is not the restaurant's menu or wine list that is of primary concern but whether they actually have a power plug conveniently located near a booth that creates the true ambiance. In the case of palmtop or laptop devices, there is obviously a trade-off between versatility and usefulness of a product and its battery size and weight. If a number of the most wanted features of single-function products are combined into one device (e.g., phone, fax/modem, computer) the power and space needs increase sufficiently for this question to become even more critical.

(4) Almost all advertisements for mobile telecommunication devices have at least one scene at the beach. Does this assume that such devices are impervious to sand blown about by the wind? (They do show the breeze swaying the palm fronds, don't they?) And again, even the safest beaches of the world don't recommend that you leave your wallet behind; why then would they be happy to have you abandon your $1000+ portable electronic device on your beach towel while you go for a quick dip in the ocean? Or are the manufacturers fast at work on water- and sand-resistant devices?

A dedicated cellular telephone user (actually, a marketing manager for a cellular telephone company) confided the following story: Upon obtaining his first cellular telephone, he carried the device with him at all times. Once the telephone rang while he was in the bathroom. The caller needed certain business information immediately. (Isn't that why many carry their phones with them, for instant response and reaction?) In this case, it dawned on the manager that the cellular telephone was nothing more than a medium - rather useless if one lacked access to necessary data or information to relay through it. To respond to a business call, one is still in need of the vast resources typically only available at the office. Such resources are still as likely to be (a) with someone else (b) in paper-based rather than electronic form, or (c) more credible without the sound of flushing toilets in the background. He learned quickly to turn off his cellular phone at times; later he weaned himself from taking the phone everywhere he went. Now that experience would be well shared if it appeared on his company's instruction manual for new subscribers!

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FIBER OPTICS DEPLOYMENT IN THE U.S. VIA NON-TRADITIONAL RIGHTS-OF-WAY

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1. ABSTRACT

This discussion group will discuss how it is possible to construct state-of-the-art fiber optic infrastructures based on the U.S. model. This U.S. model will consider the use of non-traditional rights-of-way including railroads, transit authorities, electric utilities and cable TV companies.

2. INTRODUCTION / BACKGROUND

The results of the Maitland Report depict a severe global imbalance in the distribution of basic telephone service. The focus of this paper is to show how developing countries can, based on the U.S. example, economically justify construction of a fiber optic infrastructure. By using rights-of-way traditionally utilized for a singular purpose (transportation, electric power distribution, and video programming), significant economies of scale can result by exploiting a dual purpose scenario. Under this dual purpose scenario, the rights-of-way of railroads, transit authorities, electric utilities and cable TV companies could be utilized for the placement of fiber optic cable, helping to cost justify and promote the development of telecommunications services.

The fiber optics infrastructure discussed here is applicable to both local and long distance trunking requirements (i.e., Central Office to Central Office). It is anticipated that various wireless technologies would be utilized as the local loop architecture of choice for most end users in developing countries.

3. RAILROADS

Although telegraph wire has been strung along railroads in the U.S. for over 100 years, the placement of fiber optic cable along railroad rights-of-way is a relatively new phenomenon. Beginning in 1983, MCI Telecommunications installed the fastest single mode fiber optic system in North America, operating at 405 Mbs in the Los Angeles metropolitan area, partially along Southern Pacific Railroad rights-of-way (side note -- this author was the MCI Project Manager). Ironically, MCI contracted with Western Union, who had operated the largest telegraph network in the U.S. since the mid-1800s.

Then, in 1984, MCI struck a deal with AMTRAK to construct a 450 mile route between Washington, D.C. and New York. CSX allowed MCI the prospect of installing fiber optic cable on up to 4000 miles of rights-of-way for 25 years at a cost of $32 million, providing a gateway to MCI throughout the eastern United States.

Indeed, the railroads in the U.S., in response, were beginning to see the advantage of striking agreements with fiber optic communications carriers as well. In a confidential report to the American Association of Railroads (AAR), the railroads were urged to team up with the common carriers for mutual benefit. In addition to receiving payment from the carriers for the lease of their rights-of-way (typically $8000/mile, one-time), the report to the AAR noted that railroads would benefit from fiber optic systems allowing the railroads to replace their own internal microwave or leased circuits with fiber optic capacity.

While noting that railroad dealings with MCI had been for the purpose of leasing rights-of-way only, the report said that other carriers might be more "openminded" and strike partnership deals with the railroads. Other types of agreements the report suggested railroads might want to enter into with fiber optic carriers included: presale and installation of optical fiber on "a condominium basis" (multiple carriers in a common right-of-way); whole or "carrier's carrier" agreements, where capacity could be sold before capital costs were incurred; or as a retail fiber optic carrier.

The aforementioned study was to become a very influential piece of work. For the next major announcement to impact the marketplace, the CSX Railroad and Southern New England Telephone formed a venture called Lightnet. Lightnet billed itself as a "carrier's carrier", allowing other carriers to buy or lease capacity along its fiber optic network. This network initially ran 5000 miles through 22 states.

Since the mid 1980's, the U.S. has seen vast numbers of carriers utilize railroad rights-of-way. These include Sprint, AT&T, Litel, LDX Net, SouthernNet, RCI, Cable and Wireless (Electra), and Microtel to name a few. By 1987, MCI, Sprint, and AT&T had all completed nationwide coast-to-coast fiber optic networks, primarily along railroads.

BEST COPY AVAILABLE

Today, some railroads continue to aggressively promote the use of their rights-of-way for the placement of fiber optics cable. SP Telecom, for example, markets over 15,000 miles of Southern Pacific rights-of-way, primarily in the Western part of the U.S.. A carrier may own or lease conduit, capacity or dark fiber in addition to SP Telecom offering "turn-key" fiber optic construction capability. Additionally, SP Telecom offers "one stop shopping" for carriers wishing to lease other railroads' rights-of-way along with its own. Railroads in developing countries could do this as well.

4. TRANSIT AUTHORITIES

Numerous metropolitan transit authorities (MTAs) in the U.S. are opening their rights-of-way to telecommunications carriers and consortiums of every type imaginable for the placement of a fiber optic based telecommunications system. Their motivations are typically two-fold. The MTAs usually receive both a "free" internal telecommunications system and a share of "non-fare box" revenue to be generated by the carrier or consortium in exchange for the use of its rights-of-way.

One example of this is in Northern California where the San Francisco Bay Area Rapid Tranist District has issued a "License Opportunity for Telecommunications Use of BART Rights-of-Way". The proposed system will employ fiber optic technology as its "backbone" along the District's rights-of-way (ROW) throughout the Bay Area. Additional components, including cellular and paging services, AM/FM re-broadcast and cable TV re-broadcast, will expand the usage and features of this fiber optic network so that its full potential can be realized. BART expects the final result of this proposal process to produce a unique expandable and fully operational system that will provide a full range of services to BART's riders and the citizens of the Bay Area well into the next century.

Additionally, BART is also seeking qualified developers to address BART's internal communications needs as part of their proposal. It is anticipated that the developers would both enhance BART's existing trunked radio system and fiber optic network that is in place along its extensions. BART envisions a synergistic, fully utilized "Telecommunications Highway" that may require creative alliances, joint partnerships and business relationships to take full advantage of existing and emerging technology and BART's strategically placed rights-of-way.

BART sees a primary fiber optic licensee as its partner, manager and primary interface between BART and all secondary licensees. Secondary licenses include fiber optic, cellular, paging, Cable TV, and AM/FM Re-Broadcast. BART will require license fees as follows:

a) A one-time entry fee, or initial payment, payable by all licensees upon execution of a license agreement.

b) An annual fee, calculated on a component-by-component basis. For instance, the fiber optic cable annual fee is calculated on a per-cable-per-foot-per-year rate multiplied by the route miles for Existing Lines and Extensions.

c) A percentage of revenue from each component of the developer's project. Each proposal shall describe in detail how the percentage of revenues is calculated and the method by which BART will be able to audit and verify that percentage.

d) A Consumer Price Index (CPI) escalator fee.

Other MTAs across the U.S. have launched similar ventures. These include the Dallas Area Rapid Transit (DART), the Metropolitan Atlanta Regional Transit (MARTA), the Metropolitan Transit Authority of New York, the Los Angeles County Metropolitan Authority and the Massachusetts Bay Transportation Authority (MBTA).

As a model for developing countries, U.S. based Andrew Corporation has taken this concept to Russia. Andrew Corporation, in concert with St. Petersburg Metro, has formed a Russian-American Joint Stock Company called "METROCOM". According to a spokesman, "Metrocom will re-equip and modernize Metro Communications systems and have exclusive system rights-of-way. We will be able to greatly expand the existing communications system and become a 'carrier's carrier' for cellular telephone operators, satellite gateway carriers, banks, radio and television, cable TV and other commercial users."

This project is similar to another Andrew project in Russia called "MACOMNET", an Andrew-Moscow Joint Venture. Metrocom will develop a fiber optics communications network, using the tunnels and rights-of-way of the St. Petersburg Metro to provide telecommunications carrier revenue service to commercial and city government customers. Additionally, radio based voice and data services will be provided for Metro operations and city government services (police, fire and ambulance).

5. ELECTRIC UTILITIES

One of the first examples of electronic utilities entering the telecommunications carrier business occurred in the U.S. in 1985. Five midwestern utilities banded together to create five subsidiaries that, in turn, built a 650 mile fiber optic network known as Norlight. The utilities included Wisconsin Public Service Corporation, Dairyland Power, Wisconsin Power and Light, Madison Gas and Electric, and Minnesota Power. Norlight now runs from Minneapolis, Minnesota to Chicago, Illinois to Green Bay Wisconsin.

It is also interesting to note that Norlight and other electric utility builds sparked the creation of optical power ground wire (OPGW). OPGW is a composite ground wire that contains a fiber optic cable in its core and replaces the static ground wire than transverses electrical transmission towers. Many manufacturers developed products for the new utility market, with the largest being Alcoa Fujikura, Ltd.

Since Norlight, many electric utilities in the U.S. have placed fiber optic cable along their rights-of-way for both internal and external use. At least 60 U.S. cities and their associated power utilities, especially those owned by local municipalities, now provide telephone and cable TV services and hundreds more may do the same due to the U.S. Cable Act of 1992. This cable act affirms the right of cities and their utility operating units to be in the cable TV and telecommunications business.

An example of this trend is Pacific Gas and Electric Company (PG&E), the largest gas and electric utility in the U.S., servicing 95,000 square miles in California. PG&E in 1992 traded the use of its rights-of-way to long distance carrier MCI. Under this agreement, MCI would provide PG&E a certain amount of capacity on MCI's nationwide telecommunications system in exchange for use of two parts of PG&E's system.

First, MCI received the right to use a specified number of PG&E's rights-of-way in Northern and Central California. The agreement also allowed MCI to request PG&E to install OPGW on transmission towers within its rights-of-way and MCI would use the OPGW as transmission cable for its system.

In some places, the OPGW would replace the existing static ground wire and serve the same functions of safety and system protection. The OPGW would be connected with other components of MCI's system through splice cases mounted at the base of certain towers, and MCI would have access to these cases. PG&E would design, construct, install, maintain and repair the OPGW to MCI's specifications and at MCI's expense. MCI would supply the OPGW, but legal title would pass to PG&E on delivery.

MCI also received the right of limited use of PG&E's internal fiber optic telecommunications system. MCI's use was limited to the "dark fibers" of PG&E's telecommunications system running through various portions of the San Francisco Bay Area. MCI had a further right to require PG&E to upgrade or increase the number of dark fibers in its system, at MCI's expense.

Another electric utility, the Sacramento Municipal Utility District (SMUD) in Sacramento, California, has been so beseiged by various entities to use its rights-of-way that it has contracted with the author to develop a fiber optic market analysis. The purpose of this analysis is to determine the proper strategic positioning for SMUD to use in negotiating leases of its rights-of-way or potential joint ventures.

Additionally, many Competitive Access Providers (CAPs) in the U.S., that provide services that compete with the local telephone companies, have struck various deals with electric utilities. The largest CAP in the U.S., Metropolitan Fiber Systems (MFS), struck a lease of conduit space deal with Southern California Edison as well as other utilities across the U.S.

Teleport Communications Group (TCG), the second largest U.S. CAP, has consummated many deals as well, one notably with TU Electric in Dallas. This license agreement provides for an annual license fee of approximately $5.00 per linear foot times the number of conduit feet utilized. In addition, TCG will reimburse TU Electric for all engineering and construction costs.

Recent developments in new technologies enabling electric power demand side management (DSM) to both business and residential end users may also further spur the use of fiber optics and fiber optic/coax hybrids by electric utilities. One product known as Power View (First Pacific Networks) promises to serve as a model to economically justify the construction of new infrastructures based on savings from consumption as a result of DSM.

Another model is the Russian example. Their electric power industry is quickly becoming a key player in the development of the telecommunications infrastructure of the country. Russian power companies have already installed several hundred kilometers of fiber and could soon play an important role in the development of an 8000-Km trans-Siberian fiber optic link. Russian power companies have already installed fiber networks between St. Petersburg and Finland and the Baltic nations, the Lokbosk peninsula in the north, and within St. Petersburg itself.

Fiber Technology is attractive to the Russian utilities partly because of its low cost, high reliability and rapid construction time using OPGW. Utilities are also able to support both fiber and electrical networks using one administrative infrastructure. Russia has about 30,000 support staff who maintain telecommunications for power grids across the country.

6. CABLE TV COMPANIES

Cable TV companies in the U.S. have been very aggressive in offering fiber optic based telecommunications services. TCI, the largest U.S. based CATV provider, has announced plans to spend $1.9 billion to upgrade its coaxial cable plant to a fiber optic based infrastructure. TCI is creating so-called superhubs in a number of U.S. cities, including Denver, Pittsburgh, South Florida/Miami, the San Francisco Bay Area, Chicago, St. Louis, Salt Lake City, and Hartford, Conn..

The company will consider making capacity on its fiber routes available to CAPs to link user sites to long distance carriers' points of presence. TCI also owns a 30% stake in one CAP, Teleport Communications Group (TCG), the second largest CAP in the U.S.. TCG said it will consider leasing capacity in order to access markets that lack competition in the local loop.

TCG, in addition to being 30% owned by TCI, has three other partners. Cox Enterprises owns 30%, Comcast owns 20%, and Continental Cablevision owns the remaining 20%. Additionally, TCG has signed letters of intent to establish joint ventures with 11 other major cable television operators to build new local fiber optic networks and expand current operations. New joint venture partners will be Cablevision Industries, Inc., Crown Media, Inc., Hyperion Telecommunications, Inc. (a unit of Adelphia Communications), InterMedia Partners, MacLean Hunter Cable TV, Times Mirror Cable Television and Viacom Cable.

As a result of the joint ventures, new fiber optic networks will be developed in Detroit, Miami, Providence, Phoenix and St. Louis. Some of TCG's existing networks, including Boston, Chicago, Dallas, among others, will be expanded. The following chart illustrates the extent of TCG joint venturing in major U.S. cities:

TELEPORT COMMUNICATIONS GROUP
JOINT VENTURE PARTICIPANTS
(by city)

Boston	Continental, TCI
Chicago	Continental, TCI
Dallas	TCI
Detroit	TCI, Continental, Comcast, Cablevision Industries
Houston	TCI
Los Angeles	Times Mirror, TCI, Cablevision Industries, Comcast, Continental
Miami	TCI, Continental, Comcast, Adelphia, MacLean Hunter
Omaha	Cox
Phoenix	Times Mirror
Providence	Times Mirror
San Diego	Cox, Times Mirror
San Francisco	TCI, Viacom, InterMedia Partners
St. Louis	Crown Media
Seattle	TCI, Viacom

Other cable TV companies as well are constructing fiber optic based infrastructures capable of supporting telecommunications. Time Warner, the second largest U.S. cable TV provider, is constructing a new, 4,000 subscriber model for the future in Orlando, Florida, with services ranging from interactive learning and games to home shopping to personal communications services (PCS). For business, services will include CAP services, data transmission and video conferencing. This model could be applied to certain developing countries as well.

7. CONCLUSION

By employing creative uses of existing rights-of-way initially constructed for a singular purpose, developing countries hopefully will be able to use the U.S. models of railroads, transit authorities, electric utilities and cable TV companies to economically deploy a fiber optics based infrastructure. This will enable these countries to construct an information superhighway and fully participate in the information age of the 21st century.

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CONDUCTING BUSINESS IN JAPAN
FOCUS ON RELATIONSHIPS

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Abstract

Mr. Masaru Kawajiri will focus on how to establish "relationships" for selling to Japan, based on his two decades of experience counseling American companies. Mr. Kawajiri is a mentor for American companies selected under the U.S. Commerce Department's Japan Corporate Program (JCP) to help promote American companies sales in the Japanese market. The Commerce Department selected 20 such companies and General DataComm (GDC) is one of them. Mr. Thomas Buchert will share his experiences as Director for the Japan Corporate Program for GDC. He will discuss his real experiences in dealing with GDC's Japanese OEM partner, distributors, and customers.

BY MASARU KAWAJIRI
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1. Introduction

The author will focus on how to establish "relationships" for selling to Japan, based on his two decades of experience counseling American companies. He believes that the key to succeed in Japan is to establish "relationships" while maintaining important prerequisites for successful marketing in Japan such as product "quality". He will elaborate what this means for American business, by citing actual examples of American business success and failure. The author is a mentor for American companies selected under the U.S. Commerce Department's Japan Corporatre Program (JCP) to help promote American companies sales in the Japanese market. The Commerce Department selected 20 such companies and General DataComm is one of them.

2. Prerequisites for success

You can never be competitive in Japan unless you establish excellent "relationships" with your customers (NTT, new common carriers, users, distributors, OEM partners, and regulators)! You may argue that maintaining relationships is important in any country. Yes, it is important; however, it is critical to understand what this means to foreign companies doing business in Japan.

So much is said about "quality," "presence in Japan," "delivery", "after-sales service" and "distribution channels." These are only the minimum requirements for being successful, that is these are prerequisites to the development of "relationships." It is with the establishment and development of relationships, based on demonstrated product quality, product support and company commitment that successful business really begins. For instance, Japanese no longer talk much about "Quality". Quality is taken for granted much like the air we breathe everyday. To illustrate, I can share a number of case studies of American corporate failures in the Japanese market, even when they had the right products and maintained adequate quality control, equal to and higher than that of Japanese companies. These episodes will be shared at the Discussion Group. So please come and join us.

3. Competition

First of all, you have to realize that you will be competing with such world-class companies as NEC, Fujitsu, Hitachi, and Oki, in the area of telecommunications. It is also a fact that Japanese customers do not necessarily buy your products just because Japan is under pressure to reduce its ever growing trade surplus and import more. If you are truly successful, it will be because Japanese customers feel as comfortable dealing with you as dealing with Japanese companies.

Here is an example of an American telecom company which decided to hold its own product show in Tokyo. The president of this company thought for many days what the theme should be to attract Japanese customers. Finally, he thought that he had come up with a brilliant idea, that is, "QUALITY", and he was so excited about this theme. He ordered his staff to plaster "Quality" all over the product displays. What was the Japanese audience's reaction? "What's wrong this company!" was the reaction.

There is little doubt that the level of quality control in Japan is the highest in the world. Before you begin to establish "relationships", you must prove that the quality of your products has reached at least the minimum level required for the Japanese market. Japan is often criticized for excessive quality requirements. This emphasis on quality is not likely to change quickly. It is self-defeating to argue, as some do, that excessive quality acts as a trade barrier. You have to live with it, if you wish to do business in Japan. Trade surpluses and other political considerations do little to help individual foreign companies to sell to Japan.

4. How to establish your relationships

For establishing relationships, it is important for you to be able to eat raw fish and drink a lot of sake with your customers. Right? Wrong! You may be asked but won't be required to sing songs at a Karaoke bar in Ginza either. The most important requirement is that one should go back to the basics of doing business in Japan: (1) to make sound investments; (2) to make a long-term commitment; (3) to be patient; and (4) last but not least, to have a CEO who understands and gives personal support to these basic requirements.

In reality, however, many CEO's do not seem to understand what establishing relationships means in Japan to their companies. In fact, while there are many American businessmen working very hard and effectively to try to establish good relationships in Japan, many do not enjoy support from their bosses in the U.S. I hear that CEO's complain that their Japan reps spend "too much money" and take "too much time" and don't achieve "enough sales." Usually, upshot is that these hard-working marketing managers in Japan leave their companies.

Again, these U.S. companies may already the right product. But, because they lack support from the top, these companies frequently do not maintain an adequate presence in Japan and have little opportunity to localize (or "Japanize") their products to meet customer requirements.

5. Benefits of establishing "relationships"

Once a company establishes relationships, it will enjoy some of the following benefits:

- to be able to distinguish between "hon-ne" and tate-mae". For example, when Japanese say "yes", it may mean something quite different from what it means in the U.S., as President Clinton tried to explain to Russian President Boris Yeltsin on the back of a napkin recently.

- to be in a position to have Japanese friends tell you which companies you should team up with to establish a corporate alliance (for OEM/joint venture arrangements, increasing distribution channels, and strengthening after-sales services for your customers, etc.)

- to be able to obtain advise from your business partners on how to overcome "Keiretsu" (corporate grouping) and other "insider"/"outsider" problems which are frequently cited as trade barriers in Japan.

6. Conclusion

Establishing "relationships" requires money, a long-term commitment, patience, and the CEO's support. Since establishing relationships requires human-to-human interaction against a different cultural background and across different languages, it is important to hire the right people for the Japanese market. Often, American companies end up hiring either "ugly Americans" or "ugly Japanese", or both. At the Discussion Group, both Mr. Kawajiri and Mr. Buchert will discuss the criteria for what is required to be a "right person" for marketing in Japan.

BY THOMAS W. BUCHERT
DIRECTOR, JAPAN OPERATIONS
GENERAL DATACOMM, INC.

GENERAL DATACOMM OVERVIEW

General DataComm is an international company which is headquartered in Middlebury Connecticut and manufactures communications products including modems and datasets, network management systems and networking multiplexers. Our products are sold around the world through a combination of GDC direct sales offices, distributors, OEMs and licensees.

We are about $200 million in total revenue and derive about one third of our revenues from international markets. Revenues from our Japanese operations represent a small but growing percentage of our total revenue. My function is as the Director of Operations for Japan. This entails managing our Japanese distributors, OEM relationships, directing GDC's participation in the Japan Corporate Program, a US Department of Commerce initiative designed to improve American companies effectiveness selling in Japan.

GDC has been active in the Japanese market for over 18 years but has yet to see acceptable business levels coming out of the country. Japan is the second largest elecommunications market in the world. In my business, two-thirds of the world market for telecom products comes from outside the USA. To my way of thinking, that leaves one-third for the USA. Japan is about half the population of the USA so my share of the Japanese market should be one-sixth of my business, say about $30 million. My job is to develop GDC's business to that level. In pursuit of my objectives I travel to Japan regularly. This is vital to success in Japan. I have just returned from my 25TH visit. Six times a year is about average for me. It has been said that you have to eat a lot of sushi to do business in Japan....and it's true.

CLASSIC MIS-UNDERSTANDING

As I said, I have just returned from Tokyo. In the past, before we staffed our office in Tokyo, I arrange my visits through various contacts including personal ones, embassy personnel and GDC's distributors. So, planning one such visit, I sent my distributor a fax asking him to set up various meetings for me with customers such as NTT, the large domestic phone company, KDD the international carrier and others. I also requested a meeting on Tuesday, April 7 from 9:30 AM-ONWARD, to discuss modem opportunities and asked my distributor to be prepared to discuss their input on market size. When I arrived in Japan, I met with my distributor and they informed me that all was set except for the meeting on the 7TH. They reported, with great concern, that they were having difficulty getting me an appointment with ONWARD and went on to inquire why I wanted to meet with them anyway. ONWARD, as it turns out, is a large clothing manufacturer in Japan and there was clearly a major misunderstanding.

The story would have had a better ending if they had gotten the appointment and we had closed a deal...but that was not the way it turned out. I included it in this discussion because misunderstandings are the norm in Japan and not the exception. As you approach the Japanese market, you need to be sensitive to the fact that Japan is very different from the rest of the world. Japanese culture, spoken and written language, appearance, behavior, food and of special importance, the way they do business are significant differences. If you learn nothing else from this paper, don't expect your traditional non-Japanese ways of conducting business to succeed in Japan...because they won't. In fact they will do your cause damage. I'll have more to say about this later on.

PRACTICAL SIDE OF DOING BUSINESS IN JAPAN

Japan is a tough market. Companies successful in Japan report that while it can take some years to become profitable, profits tend to be higher than in the US market. There are many success stories such as Coke-a-cola, Marlboro, McDonalds, IBM, NCR and others, and there have been many failures as well. The successes generally are characterized as companies with truly superior products and the patience to stick to their plan. You can win in Japan, so let's look at the practical side of achieving success here.

In any market, you have to do your homework. In the Japanese market, this is particularly important as well as difficult to do. It's important because most of us project our own requirements as those of the Japanese buyer. This almost always misses the mark.

Lets take a look at a few items to which we need to pay close attention:

1. What is the market for my product in Japan? Why will the Japanese buy it? Does my product have the right features or do I have to modify my product to suit their desires?

2. How am I going to sell my product in Japan?

3. Will the quality of my product meet the expectations of the Japanese buyer?

4. Am I prepared to provide the after sales support for my product?

5. Am I prepared to invest in building relationships in Japan and is my company willing to be patient in the process?

THE MARKET

Lets look at the market. Just because you have a good product is no reason to believe you can sell it in Japan. All things being equal, the Japanese will buy a Japanese product. In fact, all things not being equal, they will still be predisposed to buy Japanese. They are admirably nationalist and buy Japanese because it is perceived to be the best.

What sells in Japan are truly superior products or products that are introduced from the outside to fill a need not satisfied from within. I mentioned some names earlier but let me add a few. Foreign cars don't sell well in Japan, right? Wrong. Corvettes are very desirable, so are Jaguars, BMWs, Mercedes and Volkswagens. All of these are successful because they can be differentiated in the auto market. The Japanese perceive these cars as desirable and they buy them.

For mature products, most Japanese customers have their traditional source of supply and it is extremely difficult for a new comer to enter the market. Competing on price to accomplish market share growth is generally infective except in areas where companies practice open competition. When the traditional supplier can not provide for the needs of his customer, his customer will go elsewhere. That is where most non-Japanese become successful.

Much has been said about the Japanese business groups known as KEIRETSU's and the practices of buying within the group. Generally speaking, one group member will buy another's product if it meets his need. Be careful not to get to excited here because coming close to meeting the need at a higher than market price wins between related companies. You can try to sell "more for less" and it will not work, in fact, you probably will not even get an appointment.

Know the market for products of your type. Know why the Japanese buy, what features are important, what benefits they perceive the product provides. Most importantly, be aware of any changes to product shape, color, name or features that are necessary to make the product meet Japanese requirements. Also be sure you know the requirements imposed by Government or other organizations where particular interfaces, safety features, emissions (interference) and other standards are specified. Many USA firms have failed in Japan trying to sell the standard USA version in Japan.

Further, much of the literature exists only in Japanese which poses some special problems. As expensive as translation is, if you know the information is there you can get it translated. Sometimes it is difficult to find out what the requirements are. More on this later, but being represented in Japan helps here. The marketing questions are not any different than they are in your home market but, when you analyze your market situation, you can count on the fact that you probably do not think like a Japanese. All this adds to a simple truth. You need an education before you enter the market and you need to take advantage of all the help the various government and private organizations can provide. Use it. It will help make you successful.

QUALITY

Now that you have a product that the Japanese will buy, is your quality sufficient to meet the demands of the Japanese buyer?

The Japanese are the most FUSSY customers in the world. Quality is an obsession with them. What might be accepted elsewhere as a minor bug can lead to major problems in Japan. If your products develop a reputation as high quality products, it will make you acceptable in the market. Think of high quality as a minimum requirement. Shoddy quality will result in certain failure.

Consider this. In my business, which is characterized as the manufacture of reasonably complex products such as modems, multiplexer system components, perhaps the technical equivalent of a contemporary 486 personal computer, our minimum quality goal is 1 failure per 1000 items "out of the box". While we generally perform much better than this goal, the Japanese user expects this performance level! Many Japanese companies set their goal at 3 out of 10,000! However, many non-Japanese companies design their process to meet much lower standards and experience problems in the Japanese market

Some will say "that's good enough" meaning that to make the product better will cost more than the benefit is worth. In Japan, there is a pervasive philosophy know as "Keizen" meaning continuous improvement. Simply put, if something fails and you find out what went wrong and fix the system (process) so it never happens again, well, things improve. This whole process is a state of mind and is free. It helps meet tough quality standards. It has been said that quality is free. That is true but more importantly, quality is a profit maker. The bottom line is to make sure you know exactly what your quality level is before you try to enter the market and if it needs improvement, fix it before you go to Japan.

DISTRIBUTION

With quality products that will sell, the next question is "how are you going to distribute this product in Japan?" The right distribution method varies depending on product type and scope of operation.

At GDC we are presently using 2 methods. First, Japanese distributors who sell a variety of communications and data processing equipment represent our products in the Japanese market. The distributor assumes the responsibility for all aspects of selling and servicing the products. Our second method is through OEMs. An OEM is a company who buys a product and puts his name on it. He then assumes total responsibility for doing business in Japan.

Establishing multiple distributors and OEMs as market channels is acceptable in Japan but be careful not to cause conflicts in the channel.

Another would be to deal with one of the giant trading companies. It can be a fairly simple way to enter the market. These trading companies all have offices around the world making it easy to communicate with them. Going direct is also an option. Establish your own offices and do the selling with your own sales force.

All of these alternatives have pluses and minuses. The costs, effectiveness, and control varies.

One success/failure example. Coke-a-Cola and Pepsi are as competitive as you can get in the USA. In Japan, all you see is Coke...in fact you see it in vending machines all over Tokyo. It is a hot product. Coke established an effective distribution channel and the results speak for themselves.

Do your home work. Find out how products like yours are distributed in Japan. Study how the Japanese distribution system works and remember, its Japan and not your home market so expect it to be very different....because it is.

In the USA, you can have access to information concerning distribution through various US Department of Commerce sources in Washington and through the Foreign Commercial section at the American Embassy in Tokyo. Use their services, they are of benefit to you. This home work can be done without leaving home.

AFTER SALES SUPPORT

Let's talk briefly about an other subject which is not unique to the Japanese market but is so vital that we all must pay close attention to it. It's related to quality and it's related to your image in Japan. The subject is after sales support. Japanese customers really expect suppliers to stand behind their products and this is one of the major differences in the Japanese market.

Many of us have become accustomed to "Limited Warranties", "Reading the fine print", chasing suppliers who try to avoid responsibility for defective equipment and the like. In Japan, customers whether commercial or consumer expect the supplier to honor warranties without hesitation. The very fact that warranty provisions have to cut in is an editorial statement of the products original quality so suppliers are very quick to act so as not to make the issue any larger than necessary.

All this talk about quality and support sounds ominous. Well it is and it isn't. If you are not prepared for claims against defective products and your quality is not up to standard, you can be financially hurt rather badly trying to recover. However, if you understand the requirements and plan for them properly, you will look good as an outside supplier meeting the requirements in Japan.

One way to get perspective on this is to consider the old adage that "THE CUSTOMER IS KING". While this is true, in Japan the Japanese think "THE CUSTOMER IS GOD"! If you adopt this perspective, your efforts in Japan will be more successful.

Now all this sounds expensive. It is and the market price reflects the practice. So when it comes time to negotiate price with an OEM candidate or distributor, or you go direct and are setting your prices, remember the market requirements are a bit different here. As an example, you buy some product in the USA and it comes with a 90 day warranty and the sales person says to you, "For $29.95 we will extend the warranty to 12 months and provide on site maintenance." If you were to buy the same product in Japan, the price would include the on site maintenance for the year and on comparison, the price would be higher. Nothing is free, it is simply a matter of knowing how business is done and what customers expect.

Installation is another area where a different philosophy shows up. In the USA for example, when the installation of a product by the supplier is required (a computer or modem etc.), the installer arrives, performs the installation, runs a few tests, asks the customer to sign the installation order accepting the work as completed and quickly exits. A fee is charged for this service. The same general scenario exists in Japan and the fee is roughly the same except here, the installer will spend more time to insure that the installed equipment is working properly and will continue to do so after he leaves. This can extend the installation time for some complex equipments several days beyond that which some might feel necessary. It is all intended to satisfy the customer (GOD). Expect things do go wrong because they always do. Japan is not immune from trouble. Except here, if the incident is significant, say a power supply fails and the system goes down, most companies would install a new supply and forget it as just another routine failure. In Japan, under these circumstances, a very senior company executive will visit the customer and apologize for the inconvenience the failure of the equipment caused the customer, explain in technical detail the nature of the failure, describe to the customer the action the company is taking to insure that the problem will never occur again and thank the customer for his patience in this unfortunate inconvenience. With all the differences that exist in the Japanese market, one similarity is that when one of these visits occurs, senior executives become very unhappy. This has its benefits on quality improvements as well.

RELATIONSHIPS

Earlier, I mentioned KEIRETSU which refers to relationships and is usually discussed in negative terms when discussing Japanese trade issues. Whatever you may think about Japanese business practices relative to fair trade issues will not help you do business there today. Things may change but for now, business is done the way it is done and if you want to play in the game, learn how to win under the current set of rules.

Relationships are everything in Japan. The Japanese buy from people they know and trust. Without creating these relationships suppliers do not have anyone to sell to. So, rather than selling in Japan, spend your time developing relationships and after a suitable time these relationships will be the source of your purchase orders.

Exceptions to this exist. When a Japanese customer finds himself in need, the time to establish a relationship can be very short. Nevertheless, a strong relationship developed over a period of years with the right partner is very valuable. You become the trusted "friend" to whom they will remain loyal....through those tough spots we all face such as business downturns, quality problems etc.

To develop these relationships you must have a visible presence in Japan. To establish this "presence" your representatives must visit your customers regularly. Frequent visits by key personnel are necessary to demonstrate your commitment to the market.

Setting up a liaison office helps to develop presence. It is an expensive undertaking but worth it. Such an office provides the day to day contact necessary to convince your customers that you are serious about the Japanese market. Without such an office the Japanese wonder about your sincerity. Benefits that accrue from a Japanese office include access to market information through Japanese nationals who speak and read the language. Local personnel can regularly visit your customers. Also, mind share is important when you are dealing with distributors who represent a number of other vendor product lines.

It is also important to have key senior executives (CEO, President, VPs etc.) regularly visit your office, your distributor and when possible, customers. This has a very positive impact on the Japanese perception of your commitment to and dedication toward understanding the Japanese market. Not providing for these visits is seen as a sign that you are not sincerely interested. Remember, you have to be there to develop the relationship. The more people your customers see the more they will feel comfortable about your company as a potential supplier. The Japanese market needs are so different that it is almost mandatory to establish presence there to stay current and manage your relationships.

SUMMARY

To recap, let's see where we have been.

1. Know your market, competition etc. Use all the methods you can to do your homework.
    - Literature-news letters, reports on the market etc.
    - The US Department Commerce Japan Desk.
    - Tokyo Embassy Foreign Commercial Service.
    - Trade shows.
    - American Chamber of Commerce in Tokyo.
    - American Electronics Association in Japan.
    - Associations specific to your product type.
    - Networking-all of the above will lead you to sources of information pertinent to your product types.

2. Learn as much about the distribution system in Japan as you can and then select the proper method to use. Do your home work and get educated.

3. Quality-make sure you understand the rules.

4. After sales support-you must provide quality service and support to be successful.

5. Relationships are the essence of doing business in Japan. Build them and continue to work on them and you will be pleased with the results.

You would not enter a new business anywhere else in the world without knowing your chances of success are high. Entering the Japanese market requires the same preparation except the rules of the game are quite different so expend the effort to become well informed.

The Emerging Marketplace of Communication Satellites in the Asia-Pacific: A Case Study of AsiaSat I and Star TV

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ABSTRACT

This paper looks at the recent trends in the Asia-Pacific satellite marketplace. Using the rather pheneomenal success story of AsiaSatI and its mutichannel pan-Asian broadcasting service- Star TV- as a case study, the paper analyzes the emerging policy implications of the advent of multichannel television service across Asia.

Introduction

Disparities in both operation and provision of telecommunication facilities and services between the developed and the developing world triggered the International Telecommunications Union (ITU) to institute an independent commission to suggest recommendations that could remedy the structural flaws that characterize the telecom infrastructure in much of the developing world. Ten years have passed since the publication of the commission's study, popularly known as the Maitland report. While political and economic barriers still continue to impede the infrastructural development of telecommunication in much of the developing world, nations, classified as LDCs and NICs, have initiated or are in the process of fashioning varying forms of deregulatory measures. Governments have increasingly become aware that telecommunication is a critical component for long term economic development. Various studies and research reports bear testimony to the role of telecommunications in a nation's overall economic growth.

Consequently, the deregulatory climate ushered in a vast array of communications technologies into the marketplace. These technologies have radically altered the way we speak, listen, and interact with one another even in the remotest regions of the globe. While some of these services such as direct broadcast satellites, VCRs, cable television, value added networks were already well established in the rich industrialized nations, the late eighties witnessed the developing economies of the world adopting newer and newer technologies with unprecedented pace. It is estimated that there are now more than one billion television sets in the world, a 50 percent increase over the last five years. The number is expected to grow by five percent annually and twice that rate in Asia, where a half of the world's population live. There are also more than 300 satellite delivered television services delivering programming to as much as 150 countries. [1]

The pace of change has been particularly rapid in parts of Asia where communication technologies have given consumers new modes of television viewing. No other technology in recent times has captured as much attention among policy makers, industry professionals, and academic researchers as Star TV, an over the air privately owned free multichannel television service. Star TV has virtually revolutionized the marketplace of broadcasting in Asia-Pacific. This paper uses Star TV as a case study to analyze the trends in satellite communications in the region. In order to understand the emerging marketplace of satellites in Asia, this paper, before discussing in detail the success story of the first commercial regional satellite system, AsiaSat I, offers a brief review of the major trends in the satellite market in Asia. The next section specifically examines the rather incredible success of Star-TV as a popular entertainment and information medium. In conclusion, the major policy implications of a pan-Asian broadcasting network are analyzed.

Satellite Communication in Asia-Pacific: An Overview

Industry observers predict a growing demand in the use of communication satellites in the Asia-Pacific region in the next few years. The telecommunication marketplace in the region has grown substantially and has stimulated plans for deployment of numerous new and/ or repositioned communication satellites. These satellites will serve growing demand for basic telephony, enhanced telecommunication services, broadcasting , and cross border data transfer applications. Evidently, the satellite marketplace in the region has been witnessing a tremendous surge in the number of communication satellites. Currently, there are six operational domestic systems employing 16 satellites, and three regional systems employing five satellites. It has also been estimated that the total number of satellites capable of providing a signal, in one or the other part of the region, exceeds 40. [2] However, very few nations in the region own and operate their own respective domestic satellite systems. The launching, tracking, and maintenance of satellites are highly capital intensive and therefore lesser developed nations in the Asia-Pacific region do not have the economic means to do so. But global satellite providers like Intelsat, Inmarsat , Intersputnik, and regional cooperatives like Palapa, AsiaSat etc. provide a variety of services to fulfill the basic communication needs of these countries. The major players in the satellite market of Asia-Pacific can be classified into three major categories- global, domestic, and regional.

Global Systems

Intelsat: Intelsat has responded effectively to the changing trends in the marketplace by deploying satellites that serve the customized needs of countries in the region. Intelsat services are primarily used for international/domestic dense-traffic PSTN, broadcast satellite television, and meteorological analysis. It has four operating satellites in the Indian ocean region(IOR) and an equal number in the Pacific Ocean region (POR). Over the last five years, Intelsat recorded a traffic growth of 178 percent in the POR and 69 percent in the IOR. Intelsat has a captive market in the region because the end users of its services are its own signatories and therefore migration to other satellite service providers seems unlikely in the near future. Moreover, the plan to launch the Pacific Ocean Region Intelsat 7 will further enhance the services currently provided by the international consortium. It is also reported that Intelsat has registered with the IFRB two new orbital positions to cater primarily to the Asian terrestrial mass. [3]

PanAmSat: Spurred by its successes in the Latin American region, the U.S. based Alpha Lyracom's PanAmSat is launching in 1994 a global system consisting of four satellites for intra and inter Pacific services. PanAmSat's Hughes 601 satellite promises additional C- and Ku band capacity for the region. The satellite, called PanAmSat or PAS-2, will have thirty-two 54 MHz transponders. [4] The satellite would serve a wide variety of voice, video, and data application throughout the region.

Intersputnik: In sharp contrast to the growth of Intelsat, the Russian led consortium Intersputnik has been relatively passive in the new and evolving marketplace of satellites in the Asia-Pacific region. Though it has plans to launch the next generation Gorizont satellites, Intersputnik has been hampered by the unpredictable political and economic climate in Russia, its major sponsor.

Domestic Satellite Systems

The current state of domestic satellite systems in the Asia Pacific region is rather unclear because a number of these ventures are still in the process of pre-launch negotiations. However, it is quite clear that nations like Malaysia, Thailand, Korea, China, Papua New Guinea, Hong Kong, and Philippines have recognized the need for satellite communications and therefore have embarked on ambitious plans to own their own satellite venture. A number of new satellite programs have been announced and it is estimated that by 1995 the region will have 10 operational domestic programs collectively employing 29 satellites and six regional systems employing a minimum of nine satellites. [5] Traditional players in the domsat sector like India, Japan, Indonesia are also gearing up to launch more satellites in the next five years to upgrade its current infrastructure.

Several transpacific systems like Pacificom (United States), Pacstar (Papua New Guinea/U.S.), Orion (international), Unicom (United States/Singapore) and re-use ventures such as Columbia (U.S.), Palapa Pacific (Indonesia),Tongasat/Gorizont (Tonga/Russia) are also in the various stages of development.

Regional Systems

Palapa: The Indonesian satellite venture, Palapa, was first launched in 1976. In its 17 years of operation, the Palapa system has progressed from providing basic communication services to Indonesia's widely scattered 13,000 islands to offering advanced voice, video , and data applications to nations in the southeast region, particularly to ASEAN members. The Palapa B series satellites now lease transponders to broadcasters in Southeast Asia for domestic transmission. Global news corporations, particularly the Cable News Network , use the Palapa system for their operations in the Pacific. The Palapa system has also enhanced its international presence by providing access to multinational television conglomerates like HBO, ESPN, and the Australian Broadcasting Corporation. The Indonesian venture now purports to be a true regional service through its next generation of Palapa satellites. Scheduled for launch in 1995, the Palapa C series satellites with extended capacity and enlarged footprints have the potential to compete head to head with other regional systems like AsiaSat I and global providers like Intelsat, PanAmSat for trans-pacific traffic. The Indonesian government, which oversaw the operations of the Palapa system until recently, decided to privatize the system by moving control from state operations to an entity called PT Satelindo. While PT Telkom, the state-owned telecommunications system, will continue to maintain a 30 percent share in PT Satelindo, the nation's international telephone service, Indosat, will hold a 10 percent stake in the venture. But the largest stockholder is a private company called Bimanatara Citra, which holds a 60 percent stake.[6] The privatization move is believed to make the Palapa system more responsive to customer needs and also effective in competing with other private regional satellite ventures.

The specific focus of this paper, however, is on AsiaSat I and its multichannel television service, Star TV, which has triggered a new concept of regionalism in the Asia-Pacific satellite industry. The following section details the advent of AsiaSat I and Star TV and looks at the factors that contributed to its widespread acceptance as a pan-Asian broadcasting network.

The Star-TV Saga

Analysts contend that AsiaSat I, the first commercial regional satellite, changed the course of broadcasting in Asia and consequently contributed to a spate of new private regional satellite systems that are set for launch in the next five years. AsiaSat I's broadcasting venture Star-TV mapped new avenues of multichannel television which until then was virtually unseen of in many developing economies of Asia. The success of the venture sparked new interest among multinational television conglomerates to look at the burgeoning Asian market much more closely. The recent acquisition of Star-TV by Rupert Murdoch has renewed interest in the ongoing saga of this network.

AsiaSat I was launched into a geostationary orbit above Singapore in April 1990 on a Chinese built Long March III rocket. AsiaSat I is a Hughes 376 satellite with 24 C-Band transponders. The satellite hovers above Singapore at 105.5 East which appears to be a strategic location for beaming its signals across the continent. At least 75% of AsiaSatI's capacity serves commercial television broadcasters, with just

25% used for telephony and associated services. Due to the popularity of the services provided , AsiaSat I, since its launch in 1990, has come to be identified with Satellite Television Asia Region (Star-TV) - its six channel free -to-air television service that broadcasts to viewers all across Asia, Middle East, and certain regions of the former Soviet Union.[7]

Early in 1991, a Hong Kong entrepreneur Li Ka-Shing, and a regional conglomerate, Hutchison Whampoa, founded the pan-Asian direct broadcast satellite network- Star TV. Star-TV, as estimates suggest, has a potential viewership of 2.7 billion. The six channels that offer programming on Star-TV are the following:

Prime Sports: The American all sports channel, Prime Sports, owned by the Denver based cable programmer Prime Network International, was the first to negotiate with Star-TV. It offers 24 hours of international sports programming.

MTV Asia: Much like the American parent in style and form, MTVAsia offers 24 hours of music programming.

BBC World Service: Round-the-clock broadcasts of news and public affairs programs.

StarPlus: A family entertainment channel with a mix of American, British, and Australian movies, comedies, specials, talkshows, and lifestyle programs.

Chinese Channel: Offers Mandarin programming to a pan-Asian audience. The programming mix include movies and contemporary dramas and sitcoms from Taiwan, China and Hong Kong.

Zee TV: Set up with the financial support of Indian expatriates in Asia as well as from other parts of the world, Zee TV targets the huge Indian audience with a mix of movies, plays, and sitcoms.

Over the past two years, however, the network has been the subject of many a debate because of the political, economic, social, and cultural consequences of free-to-air multichannel Western programming in a state controlled broadcasting environment in much of Asia. Mohammed Rahmat, the Malaysian information minister, argues that "... already there is unhappiness in Europe with violence and sex raining from the air. Here in Malaysia, communalism and communism is still a danger for us. With satellites we don't rule out the possibility of clandestine TV. It could be very dangerous for a multiracial society. "[8] Similar sentiments were also voiced by governments in other parts of the region. Despite these criticisms and the efforts on the part of governments to discourage access to satellite TV, Star TV has registered a phenomenal growth rate in the first two years of its operation.

Table 1 Star TV Penetration by Nations[1]

Nation	Star TV Homes by Feb. '93	%of TV Homes	CATV homes	% of TV homes
Hong Kong	304, 809	19		
India	3, 300, 500	17	4,116,000	21.2
Indonesia	36, 211	–		
Israel	410, 000	41	414,150	40.9
Korea	18, 945	–		
Kuwait	12, 780	5		
Pakistan	61, 239	3		
Philippines	137, 141	4		
Taiwan	1, 980 140	41	2,125,028	43.9
Thailand	32, 393			
U.A.E	72, 809	18		
China	4, 800, 000	3		
Total	11, 166, 967			

Table 1 shows that Star TV penetration varies significantly from nation to nation. But overall the network has been able to gain a sizable chunk of the audiences in countries who for years had to watch programs produced and disseminated by government monopolies. The expansion of Star TV is more significant in countries where audiences are frustrated with the rather unimaginative programs dished out by the respective government machinery in control of the electronic media. As Star TV expands in range and scope across Asia, and as new regional satellite systems plan to introduce similar services in the next few years, it is important to understand the facts which contributed to the rather phenomenal success of the first regional commercial broadcast satellite service in Asia.

The Rise of Cable Systems: Star TV programs are not encrypted and therefore are subscription free to audiences everywhere. However, programs can be accessed only with a large dish of approximately 2.4 to 8 meters in diameter. But in lesser developed economies of Asia, owning a satellite dish is beyond the economic means of a large number of the population. The rapid growth of Star TV in nations like India, Taiwan, China, and Israel would not have been possible without the rise of cable systems. Reports indicate that small and medium sized cable systems have mushroomed in China, India, and Taiwan. By April 1993, approximately 1,800 cable systems were operating in China, with 429 set up in just the first three months of the year.[9] The situation in India is similar. In these countries, cable systems pick up signals using one or two dishes and then transmit the programs either through overhead wires or underground cable to homes across cities. The cable systems charge a nominal monthly subscription fee for the programs on Star TV. But the situation is going to change once Star TV launches its five channel pay service in 1994.

Multinational collaboration: To perceive the Asia-Pacific region as a monolith is misleading. The region is very diverse and is characterized by a broad array of cultures, languages, traditions, and social norms. International broadcasters serving the area have to account for the cultural specificities of the different nations that form the continent. The challenge for Star TV, then, was to develop a software platform that would appeal primarily to the diverse consumers (mainly English speaking) across Asia. It was necessary to establish credibility as well as points of commonalty. Star's strategy to rope in multinational media enterprises such as BBC, MTV, Prime Sports, etc. was part of their effort to establish the network as an internationally credible medium. BBC's clout in the international news business and MTV's rather cult following in the music video arena easily helped establish for themselves a reputation as popular purveyors of news and entertainment in Asia. On the other hand, in this age of global media penetration when multinational media conglomerates are always in the chase for new markets, networks such as BBC, MTV, etc. found the Star TV platform the most appropriate method for expanding their businesses into the fastest growing region in the world . One should wonder whether Star TV's rapid growth would have been possible without its affiliations with these Big Name broadcasters.

Exclusive broadcasting rights: HutchVision, Star TV's parent organization, has exclusive rights to broadcasting from AsiaSat I, the regional satellite in which it commands a one-third share. AsiaSat I currently appears to be the only satellite available for the next two years for full TV broadcast coverage of Asia. Its footprint spans over 38 countries from Egypt through India to Japan and the Soviet Far East to Indonesia. Trade reports suggest that the next satellite to have such a large footprint is likely to be launched next year by Unicom which will have a longer north-south footprint from Japan to New Zealand. "By booking 10 of AsiaSatI's 24 transponders-the remainder have been leased to individual countries for telecommunications services or TV relay use by various countries- HutchVision has effectively blocked, or brought under its control, market entry by any other putative pan-Asian TV service in the short term."[10] As more and more regional satellites are launched in the next five years, international broadcasters are likely to use these carriers for transmitting programs to audiences all across Asia, thus posing a challenge to the upstart dominance of Star TV. Efforts to this end are in the process of negotiation among international broadcasters and satellite service providers in the region.

Television channel scarcity in Asia: The significant growth in Star TV's audience base implicitly attest to the fact that a majority of the people who watch the network are the dissatisfied viewers in many nations of Asia where electronic media establishments, since inception, have been government monopolies and the programs they disseminate reflect the political and social preferences of the bureaucrats in control of the electronic media. HutchVision's initial plans were to reach 15% of 13.3 million VCR-using households, or 9.4 million people, in one year and 30% by the end of the second year. The company believed that "there is a strong link between the number of dissatisfied TV viewers who purchase VCRs and the number of potential subscribers to satellite TV and/or cable services."[11] Further, governmental financial problems impeded the expansion in both variety and range of television in many parts of Asia. People had access to only one channel, at the most two or three. As Chan(1993) points out, Asians have an average of 2.5 entertainment channels compared to 25 available to viewers across North America and Europe.[12] The advent of Star TV in Asia changed the existing equation. Star TV's six channels gave viewers more options to choose from in terms of programming. Moreover, frustrated with government run news and information channels, viewers in Asia increasingly turned toward the BBC for news and information, which is a vivid point of departure from the government run television news channels.

Advertiser Support and Middle Class Boom: The channels on Star TV are primarily advertiser supported. In 1992 Star TV's advertising revenue was estimated to be around US$100 million, and is expected to double in 1993. In the initial months, the challenge for advertisers was to risk their financial resources on an upstart network with no success stories to tell. The potential success of a pan-Asian satellite network, despite its enormous reach, was in doubt because the Asia-Pacific region is so culturally diverse and there are great disparities in economic and social standards. It was unclear whether the programming would have the desired commonalty in message strategies that would make it economically viable. Nevertheless, the fact that the region represents one of the fastest growing economies in the world persuaded advertisers to take note of the Star TV network and underwrite its initial operations. According to a report by the United Nations Economic and Social for Asia and the Pacific (ESCAP), economic growth in the Asia-Pacific region is expected to exceed that of all other regions in the world during the 1992-94 period. In addition, the two largest nations in the world, China and India, had a burgeoning middle class too huge to ignore. China, the largest and also one of the fastest growing economies in the region, is to maintain its double-digit growth rate in 1993. Also Taiwan and Hong Kong with 6.7% and 6.1% growth respectively, the potential of garnering a booming middle class in the "Greater China" region became evident.[13] The emergence of a huge consumer market in the Asia-Pacific region enabled Star TV to attract transnational corporations and regional conglomerates to its pan-Asian broadcasting platform.

Another factor that attracted advertisers and TNC's was the competitive pricing scheme to reach this "unified, single market, in one easy sweep." In its pitch to advertisers, Star TV offered a package for "pioneering customers" in which advertisers could buy 4,000 thirty second spots for about US$ 2 million. A buyer had two years to "consume" the time bought, and with the deal the advertiser automatically became the share holder of the company. Based on the targeted audience, it is estimated that Star TV will cost advertisers less than US$10 per thousand people reached, against US$100-140 via regional print media. Non-package rates were also competitive. At an average rate of US$1500 for a 30-second commercial, Star TV's rates were without doubt inexpensive when compared with, for example, the US$8,000 charged by the Central Television in China and US$3,460 in Taiwan for 30-second spots.[14] The cost per thousand rates for advertisers are based on the targeted audience, and therefore it is not quite certain whether advertising on Star TV translate effectively into sales. Moreover, disposable income varies significantly from nation to nation in the Asia-Pacific region and also several products advertised on Star TV are not available in many countries due to economic and social regulatory constraints. However, it appears that advertisers on Star TV have been able to slowly build up their brand names in a region where the current economic liberalization trends are beginning to usher a huge consumer boom. As one Star TV official put it, "as of 1991 there was a total of 33.5 million individual in Asia with monthly incomes of over US$750. By the year 2000, this will have increased to over 185 million individuals or more than 55 million households (excluding Japan and India). Once India and Japan are included, one can assume that there will be 400 million middle class consumers in the region by the close of the decade."[15]

The New Player

It is still not clear, because of the lack of adequate information, whether Star TV has been profitable over the past three years. What is quite clear and evident , however, is the immense growth and popularity the network enjoys in Asia, especially in India, China, Taiwan and Israel. With the planned launch of more commercial regional satellites in the next two to three years, similar satellite television services could counter the initial advantage Star TV enjoys in the Asian broadcasting scene.

The scenario has become much more complex with the advent of Rupert Murdoch and his News Corp in the Asian market. On July 26, 1993 Rupert Murdoch decided to pay $525 million in cash and stock for a 64% stake in Star TV. Murdoch's entry attests to the vast potential of this growing market, characterized by startling growth figures. During the last two decades Asia has been ahead of the world in terms of economic growth. The growth has been especially extraordinary in East Asia where the figures have grown by 7% a year, compared with 2.5% for the Western industrialized world, 3% for Latin America and a little over 2% for Africa. "Yet even India, Asia's big laggard, managed almost 5% over those two decades." The World Bank estimates that over the next ten years East Asia will continue to outgrow the rest of the world by at least two-to-one, and India by one-and-a-half-to-one.[16] With the Star TV acquisition, Murdoch has extended his global media empire to a region of the world where long term benefits appear promising. In a recent article on the changing broadcasting scene in Asia, *The Economist* said , "in buying into Star TV, Mr. Murdoch is buying into the idea of a middle-class Asia.

Aside from the promising potential of the Asian market, Murdoch is also buying into two other factors that might serve his corporation in the long run. Murdoch's News Corp has an established presence in the international media market, mainly in North America and Europe. Asia is one region News Corp has not ventured into. News Corp owns the Fox Network, and Britain's Sky satellite service. Both these services, among others, are rich sources of programming for Murdoch and therefore he can offer programs on Star TV at no extra cost. According to a recent report in the *New York Times* "Mr. Murdoch will almost certainly use Star as a vehicle for rebroadcasting programs produced by Fox and Sky, including such popular American fare as "The Simpsons" and Beverly Hills 90210," which are thought likely to attract the sort of young, affluent audiences that major advertisers covet as much in Hong Kong as they do in Houston." The markets in North America and Europe are going through a recessionary phase and therefore acquiring a large stake in the Asian region could be financially optimistic for Western media firms like Murdoch's News Corp.

Future Challenges:

The purchase of Star TV by Rupert Murdoch's News Corp signals the arrival of competition in the Asian broadcasting scene. Star TV's promising start certainly offers the network a fair advantage over the proposed newcomers. But as new services invade the Asian sky, viewers across Asia would have the luxury of choosing a variety of multinational services that reflect their cultural and social preferences. The key is to produce and disseminate programs that bear some points of commonalty across Asia and also offer a mix of programs that reflect the cultural values specific to certain regions. On the other hand, a complete schedule of British and American rebroadcasts could infringe upon the cultural sensitivities of people and institutions in Asia. Sentiments against any form of cultural or media imperialism is sure to run high if Murdoch and Star TV ignores the rich diversity of the Asian region.

Broadcasting establishments in almost all of Asia are still controlled and managed by the government. Though liberalization trends are underway, it is highly unlikely that governments in Asia would give up their control of the electronic media any time soon. Reports indicate that with the advent of Star TV, broadcasting entities in the larger nations of Asia are witnessing an erosion of their audience to Star TV programming. Concerned with the political, economic, and social implications of such a migration in viewership, governments have realized the influence Star TV wields in their broadcasting domain. This could lead to more regulations toward imported programming and also quite possibly further restrictions on satellite dish ownership by individuals. Singapore and Malaysia already have stringent regulations prohibiting the individual use of satellite dishes by their citizens. Responding to Murdoch's entry into the Asian market, Prime Minister Mahathir Mohammed of Malaysia suggested that Murdoch's acquisition of Star TV could be his bid to "control the news that we are going to receive in Asia." If not, he asked, " why would Mr. Murdoch, a naturalized American citizen from Australia, have paid "such a fantastic price for a network that has never shown any profit ?" It is to be understood that such criticisms were the essence of the 1980s debate on the New World Information Order which pitted the Western industrialized countries against the developing economies of the Third World on the ideological issues brought about by the Western dominance of the global media output.

The operation and maintenance of a five channel pay service could be a daunting task in Asia. The technical environment in the lesser developed economies of Asia are not sophisticated enough to prevent non-subscribers from descrambling the signals. In addition, there are no regulatory mechanisms to prevent descrambling and check piracy related issues. It is also not certain whether consumers would demand services on a pay-per-view basis as these are going to be expensive for a large number of viewers. The pay service is scheduled to be carried through AsiaSat 2, which is set for launch in 1994. Star TV, by leasing 10 out of the 24 transponders on AsiaSat I, had exclusive rights for broadcasting its programs. Other potential broadcasters were faced with the problem of channel scarcity. In the coming years, with new regional satellites set to be launched, broadcasters would have adequate transponder capacity for regional broadcasting. Even if Star TV garners exclusive rights on AsiaSat 2, thereby blocking potential competitors from entering the market, new satellite ventures could utilize digital compression technology to squeeze in more number of channels on current and new transponders.

The dramatic growth of Star TV in its first three years of operation has triggered a new interest in this marketplace from international media conglomerates. Competition in the provision of satellite broadcasting services are already beginning to show. Recently, another Hong Kong venture - the TVB consortium-announced plans to launch similar services in 1994. The TVB consortium are in the process of negotiations with CNN for news, ESPN for sports, HBO for movies, Australia's AUSTV for English language programs and TVB -International for Chinese language shows to counter the dominance of Star TV in the regional market.[17]

If these trends continue, the Asian broadcasting scene seems set to experience a revolutionary transformation from a state controlled environment to one in which a vast array of international broadcasters become the primary purveyors of popular culture and information to audiences across Asia.

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THE IMPORTANCE OF TELECOMMUNICATIONS AND SPACE COMMUNICATIONS PROGRAMMES AND THEIR APPLICATIONS — INDIAN CONTEXT

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1. ABSTRACT

The wide disparity in the distribution of Telecommunication Facilities between developed and developing countries and between urban and rural areas needs to be corrected to achieve progress and make available the benefits to every body. The importance of Telecom Infrastructure Setellite Systems Development and their Applications in General with particular reference to Indian Context are examined in the paper.

2. INTRODUCTION

The development of telecommunications world wide and especially in developing countries has been recognised as the essential requirement to achieve progress, since the economic and social benefits, an efficient telecommunications system confers on any society are well understood. In the developing countries, the demand for telecommunications equipment is fast growing and the market is the largest. In a significant move, the Ministry of Communications has decided to do away with monopoly in the purchase of crucial Electronic Switching System (ESS) including the Main Automatic Exchange (MAX). Though under new industrial policy, telecom equipment manufacturing especially digital exchanges had dejure been delicensed, the Public Sector Indian Telephone Industries defacto continued to enjoy monopoly status as an extension of the Department of Telecommunications' monopoly to buy different ranges of switching systems. The very dynamic nature of telecommunications technology development is responsible for reexamination of their policies in many countries both developed and developing. These changes are pushing towards privatisation of telecommunication operating entities and the liberalisation of telecommunication markets for equipment and services. It is being increasingly realised that telecommunications are very essential tools not only in emergency but also to improve health services, commerce and other economic activity.

2.1 UNEVEN DISTRIBUTION OF TELECOM FACILITIES

In spite of the fact that there is a widespread growth in development of telecommunications we find wide disparity in the extent of qulity of services between industrial and developing countries and within the developing countries between urban and rural remote areas. The remote areas of the developing countries pose problem. The uneven distribution of telephones world over, inadequate equipment and maintenance or lack of trained staff are the key issues to be tackled. The present telecommunications environment and how the development is progressing are of crucial importance to achieve the economic and social benefits for the nations of the world.

2.2 INVESTMENTS

In the developed countries, to make the telecommunications network most upto-date, heavy investments are made by the telecom companies and the Government as well. For example, in US, Federal Government is commited to spend on Research and Development of new technologies.

"The Federal Government in USA plans to create a common set of standards and to fund research and development of the network. The Government will assure that the 1300 local telephone companies throughout the nation which own the national network, design and manage their positions of their network, full interoperability for voice, images and data travelling at high speed. Federal money will be used for research and development of new technologies and applications including high speed switches and software that will be capable of routing information travelling at gigabytes speed. Government should assure that barriers inhibiting private sector investment in network in deployment are removed".(1)

Supercomm 93's emphasis is on the commanding role that video will play in the future. TCI, the largest cable company in the world recently announced, it would spend $ 2 billion over the next two years to carry out an ambitious plan of fiber optics networks in most urban posts. (2)

3. TELECOM FACILITIES IN INDIA

There are more than 6 lakh villages in India which need telecom facilities. It is established by the studies made by the experts that telecom facilities and services are an essential part of the infrastructure such as roads, electricity and water supply, since there is a greater appreciation of this fact by the policy makers in this country just as in many other countries the neglect of telecommunications done in the past is being corrected by increased investments and by removing various policy constraints on the production of equipment, especially mobilisation of investment funds. The government constituted a committee to suggest ammendments to the 107 years old Indian Telegraph Act of 1885 to remove any legal barriers, in view of the new liberalised economicpolicies.

The number of telephones increased from 80,000 in 1951 to 5.6 millions by 1992 and at the same time the waiting list too has increased hundred fold. There are now 7 million connections in the country and on the wait list another 3 million potential customers. Higher depreciation rates for investment in telecom facilities to encourage companies to go in for their own equipment. A variety of new facilities and services available to the consumers in advanced and some of the developing countries due to advances in technology are not available in India though an efforts is being made now to make them available to consumers in urban areas. They are radio paging high speed digital data links, audio and video conferencing, electronic mail, telex and voice mail boxes, store and forward fast Fax, packet switched data networks electronic super highways, screen phones, V-SATS. for remote and ill served areas. The department of telecommunications is trying to introduce some of these services and increase the number of telephones from the present 7 per 1000 to 16 per 1000 people for which the investment required is estimated at 40,000 crores of Indian rupees during the Plan period (1991-1996). The DoT envisages that out ₨.40,000 it seeks to invest ₨.30,000 crores, it can raise from internal resources, that is from telecom subscribers and the balance from budgetary support. In India service provider, regulator, policy maker and equipment producer are the same, namely the department of telecommunications. Telecommunications should be run on business lines as a seperate financially self sustaining enterprise properly managed with effective controls. With the recent implementation of liberalised economic policy by the government, private participation in telecom development and foreign investment by way of joint ventures is allowed. This has reduced to some extent foreign exchange problem.

3.1 FUTURE DEVELOPMENTS IN INDIA

There are many new areas where extensive development has to take place in India. More than 40,000 KMs of Fiber should be added. Terrestial digital microwave and UHF radio systems to connect different metropolitan cities and towns are to be installed. The present anologue co-axial cable systems should be refixed to suit the digital system. Systems should be installed to connect customer premises to switches by radio in cities and in hilly and remote inaccessible areas. The communication satellites (INTELSAT, INSAT, ARABSAT) and the connecting V-SAT earth stations, intelligent networks providing a variety of information services have become the overlay to the existing switches.

4. INDIAN DOMESTIC SATELLITE SYSTEM

With the launching of INSAT-2A which is land mark achievement for Indian Space Research Organisation, the Indian space communication system has attained a significant place on par with the world satellite systems. There is a world wide trend to develop domestic satellite systems and to become self sufficient in meeting the requirements of space communications. India's first indigenous multipurpose communications satellite, INSAT-2A which was launched and brought into operation in 1992 and its successor INSAT-2B has placed unprecedented communications capacity in space at country's disposal.

The history of Indian Satellite launching goes back to 1975-76 when Satellite Instructional Television Experiment (SITE) was tried. Subsequently Satelite Telecommunications Experimental Project (STEP) and Ariane Passenger Payload Experiment. (APPLE) were tried. From 1982-83 INSAT-I Salellities were launched.

Consequent on the agreement at the World Administrative Radio Conference (WARC) in 1971 for the allocation in S band of a specific frequency fortransmission of television from geosynchronous satellites, a system based on multiple beam satellite for television broadcasting directly to villages and cities, interconnecting satellite and microwave links and earth stations for the provision of long distance telecommunications to islands and broder regions was planned. The system became operational in 1983. These multipurpose satellites combine communications, broadcasting and metereological functions.

INSAT-I series were tailor made by the American Company, Ford Aerospace to Indian specifications. The second generation INSAT-2 series of satellites were designed and tested by Indian Space Research Organisation (ISRO). The INSAT-1D satellite is the last in INSAT-1 series. It will be operative till 1998 and the INSAT-2 series of satellites may provide services upto 2007. The growth of Indian capabilities, thus in satellite development has been extremely rapid. Fifteen years ago, the first Indian Satellite, 'Aryabhata', was put into orbit from Soviet Union. Now the complex INSAT-2 Satellites are being launched. Their weight is 1.9 tonnes as compared with the 360 Kgs. weight of the first satellite.

With the launching of INSAT-2 series the capabilities for telecommunications in India have been expanded. INSAT-2 will have 12 normal C-band transponders for telecommunications. The departments of Telecommunications is establishing 50 earth stations in North-East for rural telegraphy network. The National Information Centre (NIC) has more than 450 microterminals on its network NICNET. It plans to have one micro terminal at each district headquarters.

The DoT wants to use the extended C-band transponders which are of higher power to improve business communications using Very Small Aperture Terminals (VSAT). This extended C-band VSATS would permit transmission rates of 64 Kbs and hence capable of voice transmission as well.

Thus the Satellite Based Public Data Network called "RABMN" which was commissioned by the department of telecommunications consists of a master earth station located in Sikandarabad (U.P) and very small Aperture terminals located at customer permises. The Master Earth Station equipment has been imported from GTE Spacenet, USA. It is well known that the main advantage of the VSAT networks is that they can be installed with much ease and rapidity and that they are independent from the traditional terrestial communication networks. This kind of bypassing the terrestial network is advantageous from the point of cost and also saves undue delays in providing terrestial based lines.

In satellite communication system though the earth stations are geographically dispersed will have access to satellite transponder. The satellite broadcasts the signal to all the earth stations in its coverage area. For efficient utilisation of the satellite transponder capacity the band width can be shared by the multiple earth stations. The different methods used in satellite communications for this purpose are Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA) and Spread Spectrum Multiple Access (SSMA); each method is having its own merits. National Informatics Centre of Government of India is interested in setting up a satellite-based computer communication network in India (NICNET-VSATS). The code Division Multiple Access based VSAT of M/s Equatorial Communications Company of USA was selected by NICNET. The manufacture of VSATs in India was based on a technology transfer from M/s Equatorial communications company of USA which is now taken over by M/s GTE Spacenet. The VSAT networks are becoming popular amongst corporate users, since it provides them a very reliable network for data and voice.

INSAT-2A & 2B also carry a transponder to detect distress signals of the COSPAS-SARSAT system. This system is an international satellite aided search and rescue programme. Disaster warning systems are installed in villages in cyclone-prone areas of this country.

4.1 INDIA's PSLV LAUNCHING

The Polar Satellite Launch vehicle (PSLV) to take off will use liquid engines. India's previous launch vehicles used only solid propulsion. The Augmented Satellite Launch Vehicle (ASLV) launched last put 106 Kgs satellite in 400 Km arbit. PSLV mission is to put an 850 Kg Indian Remote Sensing Satellite (IRS) into Polar arbit 820 Km above earth. The PSLV will provide India with its first opportunity to enter the commercial launch market. ISRO is also targetting the PSLV at the earth communication satellites. The 275 tonnes, four stage, 44m high launch vehicle carrying 850 Kg class of Indian Remote sensing Setellite (IRS) blasted on September, 20. An error has crept in final stages. The PSLV covered 400 Km. as against it planned polar arbit of 820 Km. PSLV can be compared to Russian "VOSTOK" and other rackets of its class capability to hurl 1000 Kg. satellites into arbit. PSLV has the capacity to carry multiple pay loads or a maximum of three satellites (total weight 1.5 to 1.7 tonnes) for deployment in low earth ar its. Future market for low earth orbitting communication satellites would make it possible to have global communication with small hand-held terminals. A cluster of several such satellites is necessary. Motorola is considering having 66 satellites for its irridium project to provide continuous global coverage. The original clusters will be put up by more powerful launch vehicle such as the Titan Centaur, Ariane 5, Russia's Proton and China's Long March.

Thus with the launching and positioning of India's indigenons multipurpose communications satellites (INSAT) a great opportunity for utilisation of satellite services has come about.

5. BENEFITS

The world is drawn together now as we find vast and complex network of undersea cables, satellites in the orbit and the equipment to send and receive the news, information, money and data any where in the world in microseconds. Thus, telecommunications infrastructures are essential ingredients to national wealth, jobs and individual well being. As we examine the application of Telecommunications in the fields of health, education, public administration, metereology etc.,

The benefits are tremendous.

5.1 ENVIRONMENT

The environmental education activities related to Earth Summit held in June, were enormous. The people were kept informed not only by video tapes but by an extensive satellite coverage on Cable News Network.

ECONET is an international computer based communications system serving organisations and individuals working for environmental preservation and sustainability. ECONET like electronic mail system works by sending electronic messages through telephone lines to nodes or e-mail centres. Electronics "gate ways" allow us to send telex and facsimile messages and mail to users on many other e-mail systems and international e-mail networks. This is compatible with any personal computer or terminal connected to a normal phone through a modem.

5.2 RESEARCH

ORSTOM, a research Institute in France, is expanding its computer Network (R10) which will enable scientists working in distant laboratories to carryout common programmes and to exchange data processing tools. Most research institutes in Europe and North America are linked to R10. This covers some of the countries in Sub-Saharan Africa. These networks allow researchers to share information and facilitate technology transfer especially to scientific teams in the developing world. (3)

The lack of reliable communications with remote regions has posed a difficult obstacle in the implementation of development projects for decades. Though many regions in Aisa, Africa and Latin America are expanding communication channels through modern digital switching equipment and fiber optic technology, many rural areas continue to be isolated.

5.3 PACKET RADIO-HUMANITARIAN USE

It is claimed by the Director of Informatics at VITA, USA that packet radio which is an inexpensive digital technology may be viable low cost technology - two way radio and personal computers - in a system that permits computers to communicate with each other over radio circuits. This is analogous to computer communication via modern telephone lines and is easy to use and permits the transmission of messages, letters, spread sheets and reports without the need for manual transcription or intervention. Humanitarian use of this radio by VITA in Ethiopia (relief commission), successfully exchanged logistical information on food supplies. These network in Jamaica and Philippines have extended preparedness and search and rescue information to isolated areas during and prior disaster relief efforts. Transmission of administrative messages which required frequent repeats or the use of multiple languages can be done by pocket radio which provides for a hard copy. Non-text files such as spread sheets, and data basis results can be transmitted and thus such administrative applications will increase as computer applications beyond word processing expand. Space technology currently emphasise information exchange and dissemination on topics in health, education and energy/environment. It is claimed that VITASAT-A will be the first low earth orbiting communications satellite in history, totally dedicated to humanitarian ends. Wonderful opportunities are afforded by new telecommunications technologies such as CD-ROM, data broadcasting, small satellite antennas, and remote data base access. AID sattelite programme through Intelsat satellities in reaching distant areas and providing health, education programmes are commendable.

5.4 AFRICA-SATELITE-HEALTH CARE

In Africa due to lack of good communication facilities the news of epidemics could not be spread, advise to health care workers in times of need could not be given. Immunisation programmes could not administered speedily. A new project known as 'Satelite' is designed to make this resource available to health care workers across the regions, using micro satellites and ground stations, satelite will help health care providers and researchers who depend on up-to-date information to address health and medical problems. Health sat, a micro satellite was put into orbit. Satelite has established earth stations in Kenya, Mozambique, Tanjania, Uganda, Zambia, and Zimbabwe and in Canada. Africa suffers from not only economic poverty but also from "information poverty". There are more telephones in Tokyo than in all Sub-Saharan Africa (excluding South Africa). Healthcare workers lack of access to information is one of the important obstacles to providing quality health care in Africa. Satelite proposes to remove the constraints and provide high-techtools so that health care providers can come into direct contact with one another. The ability to communicate with colleagues via electronic mail in other countries, in region and in other parts of the world will permit health professionals exchange information. Physicians and health care workers will be empowered in developing world communities to benefit from improved communication and access to information.

5.5 DISASTER COMMUNICATIONS

A review of the global disaster statistics over the last 20 years revealed that there are approximately 50 disasters a year which require outside assistance especially from international agencies. The majority occur in developing nations. Whenever earthquakes, floods, hurricanes etc., occur, needs for food, clothing, medicine and shelter will have to be met urgently, since the number of casualties, the level of human suffering and economic losses will be significant. A tropical cyclone tidal wave that swept over Bangladesh claimed 500,000 lives in 1970 an earthquake in Tangshem, China caused an estimated loss of 700,000 lives in 1976.

Reliable communication equipment that can be transported easily to the disaster site must be a part of disaster assessment, relief response and rehabilitation efforts. Relief co-ordination cells for a network of telephone and data communications from temporary headquarters established in the disaster area, out to the national and international relief agencies.

Satellite communications are able to satisfy the requirements for a national/international disaster communication networks. Satellite capabilities include systems established by the INTELSAT, INMARSAT. They are having world wide coverage, high reliability (existing systems work more than 99 percent of the time). COMSAT designed a disaster communication system in 1977. This system has small, rugged terminals appropriate for either INTELSAT or INMARSAT Service that would connect the communication to relief agency head quarters or to any working telephone. INTELSAT even agreed to provide designated international relief agencies with some free access to satellites. INTELSAT tested light weight "fly-away" or transportable C-bond communications terminal and can provide single voice channel suitable for disaster assesment.

Even satellites can be used for advance alert. Advanced warning networks can be established through remote sensing satellites for hurricanes, earthquakes, volcanic eruptions and other disaster causing activities. They will be able to assess the results of a calamity. Within hours of nuclear accident in USSR television audiance were able to view the damage through photo and infrared images taken by commercial remote sensing satellites. (4)

6. TELECOMMUNICATIONS PRIORITY

Telecommunications are responsible for conferring social benefits also. It is not only a channel for education (distant education programmes) but also encourages self-reliance, sense of national identity and political stability. It is established by the International Labour Organisation Studies that in rural areas where communication is better, cottage industries flourish, productivity is high, employment opportunities increase and the overall soico-economic environment brightens up tending to economic and social stability. The need to increase telecom facilities in rural areas has been increasingly realised, especially to prevent migration of population to urban centres. We can think of Singapore, an island which could achieve tremendous progress and high level of prosperity because of great priority it has given to telecommunications. It has modernised the telecommunications with the latest technolocy. Singapore also benefited by regional corporation since Singapore Telecom is a partner in four undersea submarine cable systems - ASEAN, Asia-pacific, Transpacific and Se-Me-We. Through its two satellite earth stations and four submarine cable systems it has direct international links to 66 countries. Singapore Telecom is privatised in 1992. Cellular mobile radio paging, fax and telex service are extensive in Singapore. It has floated Singapore Telecom International (SIT) like India's Telecommunications Consultants India Ltd. (TCIL) to operate abroad. It has partnered with world's gaints like AT&T, FUJITSU, and Siemens in implementing their projects in developing world. Through alliances, joint ventures which are the strategies for market penetration, Singapore is able to gain much.

7. CONCLUSION

The information highways must be built. There is world wide shortage of capital which demands that companies work together, governments must keep the movement towards privatisation and deregulation.

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BROADCAST TECHNOLOGIES IN 2004:
ACCESSIBLE? AFFORDABLE? APPROPRIATE?

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ABSTRACT

Broadcasting is entering a brave new world of high technology, from all-digital audio storage processing and transmission systems to radio-by-satellite or delivered to the consumer via fiber optic cable. A large percentage of the new technology will be produced for mass markets, hence readily accessible and affordable to broadcasters in less affluent countries as well as the so-called "developed" world. Nevertheless, much that is new will prove to be a mixed blessing at best to traditional broadcasters, causing paradigm shifts to be reckoned with in the "First World" every bit as much as the "Third." In developing areas of the world, the simple fact of affordable cost and widespread availability will hardly ensure appropriateness. The following paper will review various technologies likely to mature in the decade ahead, forecast something of their impact on broadcast strategies, and conclude with some specific predictions and possibly indicated responses.

BROADCASTING TECHNOLOGIES: 1994-2004

"Digital is here to stay" was the title of an editorial in the August 5, 1992 issue of *Radio World:*

"This fall marks the tenth anniversary of the digital audio compact disc. Judging by the ever-increasing number of products introduced since the advent of the CD, digital technology has had quite an impact on audio. Radio engineers realize the importance of digital when it comes to professional products that help them get better audio on the air...

"As new digital products continue to be developed for the broadcast industry, station managers and engineers need to keep informed and up-to-date. There should be no second thoughts about going digital. It is here to stay."

For broadcasters, the qualitative advantages of utilizing digital audio technoloy as fully as possible are manifold. While a virgin vinyl LP may theoretically sound better than a CD when reproduced by fine and costly equipment, the CD that seemed every bit as clean and bright to the human ear the first time it was played will go on sounding the same *ad infinitum.* Moreover, through buffering and spindling techniques, digital reproductions can be made totally immune to such mechanical problems as wow, flutter, skipping and the like.

Meanwhile, a bevy of powerful new studio tools are fast becoming available to broadcasters from all walks of life. The digital audio tape family includes not only the professional DAT recorders and digital cartridge machines which are still beyond the budget of smaller stations, but also two relative newcomers now being mass-produced for the general public and available to stations at very competitive prices: Philips' digital compact cassette (DCC) and Sony's Scoopman.

Like the CD player, the former may bring digital audio reproduction capability to a goodly part of the planet; unlike conventional CDs, it is erasable, re-recordable, and compatible with existing analog cassette playback units. The latter is a specialized tool, an extremely compact record-playback device particularly geared to voice recording. Scoopman technology promises to make it possible for stations to make high quality field recordings of community meetings, sports, interviews and actualities, adding an important *communication* tool to every station's arsenol. In the decade ahead, this technology is bound to mature, and become mass produced, and readily available to every budget.

But the "digital revolution" has centered around the compact disc. Professional quality CD players are now available for less than the cost of an average record player ($150 for a Technics model in the U.S.). The low cost and widespread availability of the compact disc has profound implications for broadcasters the world over, who will have little choice but to embrace this digital technology as vinyl LP records become increasingly obsolete.

What is the CD's next generation? Perhaps Sony's mini disc (MD), with its considerably smaller disc format. More important, the MD can be erased and re-recorded, theoretically an unlimited number of times. The availability of the mini disc to broadcasters may soon place digital **production** capacity within the budget range of many stations for the first time, allowing bright, clean local material as well as commercially produced product to be aired.

Already, Sony has announced its professional MiniDisc cart machine line to broadcasters as part of a new all-digital studio including a sophisticated digital mixing/production console starting at $45,000. Price for a mini disc cart player is $2,200; for a record/playback unit, $3,000. But small stations everywhere will soon be able to avail themeselves of consumer mini disc hardware for much less.

Another recent digital audio development promises to impact broadcasting, for better or worse. Bellcore Labs in the United States has developed hardware and methodology to deliver "CD quality" audio over standard telephone lines and twisted pairs. This immediately opens vast new horizons to radio stations, who can essentially do "remote pickups" of the highest quality from anywhere in the world.

Since it promises high quality audio delivery over common telephone lines and twisted pairs, this development represents technology particularly appropriate to the developing world. As a host of competitors enter the market in the years ahead, the technology should also become both accessible and affordable to all but the smallest operations.

Specifically for AM, two technological developments are worthy of the enthusiastic approval of broadcasters. The first is AM stereo, which really works, and can make a good AM signal almost indistinguishable from FM to many listeners. Although it has already been around for one decade, AM stereo has yet to enjoy the support of the majority of broadcasters, receiver manufacturers or the public. The reasons are at least three:

1. Deregulation. The U.S. "marketplace" decision with reference to an AM stereo standard represented nothing less than a cop-out. **Some** regulations are in the public interest, including the setting of norms and standards for consumer products. In the absence of a government standard, confusion reigned supreme: few broadcasters and even fewer manufacturers wanted to invest in a system which might be obsolete in a few years. This caused a perfectly good technology to become stale, like yesterday's newspaper.

2. Timing. By the time one system (C-Quam) became the *de facto* standard worldwide, a great many sponsors and listeners had deserted AM, particularly in the United States.

3. Lack of AM stereo receivers. Here we have a classic chicken-egg dilemma: most listeners have long since been turned off by AM radio's noise, low bandwidth and interference problems, so receiver manufacturers see little return for what amounts to a substantial investment in the development, re-tooling and mass production of admittedly superior AM receiving technology. This is ironic, since a sizeable share of the blame for the technical failure of AM lies with the receiver companies themselves, whose answer to static and adjacent channel interference was to roll off bandwidth at around 3 kHz. A whole generation has grown up with the false idea that AM radio must by its nature sound like it came through a telephone!

But hope is on the horizon: Japan's public is embracing AM stereo, and major manufacturers are now making C-Quam receivers in mass quantities. Japan's official embrace of C-Quam is apt to have very positive reverberations on the technology in the United States and elsewhere in the world. Indeed, this one, seemingly small policy decision might well contribute more toward the rescue of the AM band than any of the highly-touted efforts of industry committees.

Why? For the simple reason that acceptance of C-Quam in Japan means a proliferation of high-quality, mass-produced AM stereo receivers, first for the internal market (which is heating up nicely), and then for the world. Already, Aiwa, Sony and Hitachi are actively producing receivers for the Japanese market, with JVC, Matsushita, Sanyo, Sharp, Pioneer, Kenwood, Sansui, Onkyo, Nippon Columbia and Clarion also coming on line. As AM stations the world over convert to stereo, receiver prices will drop, and the new quality level will greatly assist in the "rescue" AM's highly appropriate communications technology.

Another reason for optimism about AM's long-term prospects is AMAX (for AM-Maximum), a receiver technology responding to recommendations of the U.S. National Radio Standards Committee (NRSC). Modern IC techniques, and particularly digital technology, have long since rendered a receiver of high quality monaural or stereo AM signals possible. Now several exist: an AMAX "SuperRadio" tuner made by Denon in an agreement with the U.S. National Association of Broadcasters, GE's table model "Superadio III," and some AMAX car receivers built by Delco. The Denon and Delco radios feature 50 Hz-7.5 kHz frequency response with selectable roll-off and noise blanking, and may also include AM/FM stereo and continuous tuning. The GE model is monophonic and without noise blanking, but is *appropriate, already available, and relatively affordable*, retailing for less than $50 in the U.S.

The AMAX radio complies with norms recommended by the National Radio Standards Committee. Other NRSC standards adopted by the FCC include an audio preemphasis curve very much like that of FM, with corresponding deemphasis in AMAX receivers. As in TV audio and FM, system preemphasis-deemphasis greatly decreases noise.

Concurrently adopted was an rf mask, assuring 50 dB rejection at channel edge (10 kHz in the U.S.). This "brick wall" filter assures maximum adjacent and second adjacent channel rejection. Together, the two standards allow receivers to be manufactured with respectable IF bandwidth, guaranteeing reception of high fidelity signals with low noise and interference content.

Other receiver developments include RDS (below), and the *Vanguardia SR-2*, a low-cost AM table radio that can operate entirely on the light which strikes its cabinet. The *SR-2* was developed by The Vanguard Trust to respond to a *communication system* requirement for an energy-independent, cost-efficient radio receiver. Developed principally with a poor, rural population in mind, such receivers nevertheless have universal appeal in protecting the environment through the elimination of dependence on batteries. The solar radio is produced for Vanguard by the Chengdu TV and Electric Company in Sichuan, P.R. China.

BIG RADIO, LITTLE RADIO IN 2004

Digital audio broadcasting (DAB) is as certain as tomorrow, whether from terrestrial or satellite sources, whether located within present medium frequency AM and very high frequency FM bands or in other spectrum space. But the whole prospect has many conventional broadcasters shaking in their boots, and with good reason.

The prime example of DAB is satellite-to-home radio, called BSS(S) internationally, for Broadcast Satellite Service (Sound). Although the CCIR has postponed a decision on a world DAB standard due to pressures from the U.S. for an in-band system, its main proponents are backers of the European Eureka 147 format. Already, spectrum space has been allocated worldwide for direct broadcast satellite radio service.

In the United States, project Acorn and other systems are being developed for in-band DAB, utilizing both AM and FM broadcast bands. In this case, it is likely that existing broadcasters would have the option of switching to this new medium over a period of time, possibly even to the eventual exclusion of present AM and FM services.

But radio from the sky should be commonplace by 2004. And its implications for conventional terrestrial services are profound, particularly as a deliverer of near-perfect music to increasingly discriminating listeners. Satellite-based programming has already come to developed countries: on Digital Cable Radio, which is capable of delivering fibre optic-quality audio to home cable TV subscribers.

Another product of the digital audio era is the Radio Data System (RDS) or Radio Broadcast Data System (RBDS), a transmission standard defining how FM stations can broadcast data utilizing a 57 kHz subcarrier. RDS has a number of highly-touted benefits (receiver display of station call and format code, emergency alert feature, etc), but at present, paging services seem to offer the most promise to broadcasters. Wide-area paging is typified by AXCESS USA's aggressive entry with an international network granting "franchise" privileges to local FM subcarrier outlets.

To adequately consider broadcasting's response to the impact of all this technology, it is necessary to place all actions and reactions in the context of a future where all the new gadgets and systems are in place. Here are 8 predictions, each containing a survival strategy for broadcasters:

1. In many "First World" countries, the majority of widely-syndicated programming is even now distributed by satellite. In the future this trend will continue until virtually all syndicated programming will be delivered by satellite, and will be of digital "CD" quality.

By the year 2004, much of this programming will be available for satellite delivery worldwide, for better or worse. Appropriate? While a plethora of program channels will be available to broadcast outlets, a great deal of the content may be of questionable worth to specific areas.

2. In actual practice, a high percentage of syndicated programming will be distributed from satellites directly to home receivers, or to "digital quality" cable radio systems. This reality of the 21st Century will serve to **decentralize** and **localize** terrestrial radio stations in countries like the United States, and *is quite apt to compete directly for listeners* in developing areas. Audiences will increasingly tune to the sky for (generally Western) network programming, deferring to local broadcast outlets for programs of specific interest to them and their communities.

3. Musical program fare of all conceivable formats will likewise be distributed by satellite and received directly or through cable radio. Not even many FM stations will be able to fully compete with the digital carriers for delivery of high quality music formats. DAB will take over in many countries, either replacing AM and FM on their respective bands, or offering alternative media and frequencies to the listeners.

4. Hands-off radio? A good many manufacturers of automation equipment are touting fully-automated operations as a way to reduce staff and significantly alter the bottom line for marginal stations. There is probably some truth to this, particularly as a stopgap measure. Nevertheless, highly automated stations are not apt to dictate a new broadcast paradigm, for two important reasons:

1) The trend for local stations will be toward increased **communication** with the listenership, the very antitheses of what automation all-too-often represents. After all, the "automat" format is pretty much what will come out of the sky, better serving that particular audience segment from direct satellite or cable links.

2) Automation, at its finest, is a good example of technology being the "best of servants and worst of masters." Where automation **assists** the on-air personality (read, "communicator"), a tighter, cleaner operation may be the result. But when automation attempts to take the place of the human touch, however imperfect, listeners desert the station in droves. To developing countries, the point is probably moot: automation is unlikely to be either accessible or affordable, how much less appropriate in the decade ahead.

5. Almost wholly due to the competition of FM, many medium wave AM stations in the U.S. and elsewhere will leave the air. According to the FCC, more than **200** AM **and FM** stations have already discontinued operation (Cole, 24 March 93). Nevertheless, another trend is on the horizon: ever-so-slowly, a new type of AM broadcaster is emerging, one who knows how to utilize the medium for effective *communication* with the listeners. Because of its lower cost and better long-distance propogation characteristics, AM is likely to remain a solid communication medium in developing countries as well.

6. In the longer term, and as one major result of digital audio's takeover of music and syndicated programming, AM and FM broadcasters alike will find themselves with two alternatives: to serve their audience or to go dark. In general, surviving stations big and small will develop more informal, conversational and upbeat sounds, concentrating on topics and events of interest to their communities.

Good models of highly popular community-serving stations exist: one of the better known examples is found in Radio Baha'i. Baha'i radio stations are located around the world in four continents. One station, *Radio Baha'i del Ecuador*, was described by Dr. Gerald Filson in a presentation at the University of Toronto:

"Radio Baha'i Ecuador is a community station, owned by the Baha'is of Ecuador, and situated in Otavalo in an area of about 100,000 campesino Indians... The station strives to promote and maintain the value, dignity and significance of the indigenous culture, provide some educational and social service, and be a voice for the community. Broadcasts are primarily in Quechua... Staff are recruited from the local, largely illiterate population. Nonetheless, staff have been trained, on site, to create, produce and edit their own programs.

"Programming decisions are made by the staff with each member required to undertake regular visits to the campo to come to know how the broadcasts are received, and hear about listeners' needs and preferences. Broadcast fare consists mostly of traditional music, local announcements, news of important activities and events in the region..."

7. *Broadcasting* will increasingly become the purview of satellite and cable networks, while locally-based stations will concentrate on *narrowcasting* and niche programming. To truly respond to listener needs and serve the interests of various subgroups in the community will require quality research into the habits, culture and aspirations of the people. The result: participatory stations at the very center of the community and its daily life.

At present, one can drive across the United States and endlessly hear the same 6 or 7 program formats: top 40, country, oldies, MOR, etc. Although these stations are not linked, they might as well be from the way they all sound. This trend toward sameness has been referred to as "McRadio," after the chain of McDonald's fast food outlets that have all but eliminated small and unique family businesses.

As new delivery technology takes over the "McRadio" function, a wonderful thing will happen: local fare will become more creative, interesting and **human**. Listeners will be able to choose between a variety of near-perfect, sound-alike, syndicated program sources and an equal number of unique local channels.

8. Small can be beautiful. The above scenario implies the eventual replacement of some centralized terrestrial broadcast operations with a proliferation of community-serving *Village Radio* stations. Village Radio is *appropriate technology*: a scaled response of the communication media to the needs of real human beings. It is both readily *accessible* and highly *affordable*: a total studio/transmitter package may cost between US$5000 and US$50,000 **installed.**

Village Radio is a reflection of the community it serves, a village in communication with itself. It is a monitor of community life, pulsing with its seasons, festive occasions, sadnesses and joys. Its sound is uncomplicated, sincere and natural, with an oral, conversational format.

CONCLUSION

The next decade will see the release of an incredible array of "high tech," mostly digital tools for broadcasters. Driven by market forces and mass production, many such tools - digital audio, satellite delivery systems - should be accessible and affordable to the developing world. The biggest challenge to communicators will be that of *appropriateness:* how to utilize newly-available technology to ends compatible with such national and local needs as education, preservation of native language, culture and tradition, and the holistic development of the individuals and societies served.

MONDAY, January 17, 1994

NOTES

TELECOMMUNICATIONS AND DEVELOPMENT TEN YEARS AFTER THE MAITLAND REPORT:

THE NEED FOR NEW POLICIES AND STRATEGIES

by

Heather E. Hudson[1]

ABSTRACT:

The technological and policy environments have changed dramatically since the Maitland Report was issued, with new technologies available to provide rural services, increased demand for data and fax communications, and changes in the structure of the sector in many countries, including the introduction of privatization and some forms of competition. Yet these changes have not resulted in meeting the Maitland Commission goals. The paper examines to what extent goals have been met (or should be changed) and what strategies could be used in the next decade.

The paper examines the original goals set by the Maitland Commission and progress that has been made toward them. It compares telecommunications access in developing countries in 1990 and 1980, grouping countries according to economic development indicators. It then compares statistics for growth in number of TV sets during the same period. The paper then proposes policies and strategies that are needed to implement the goal of universal access to basic telecommunications.

> "We believe that by the early part of the next century virtually the whole of mankind should be brought within easy reach of a telephone and, in due course, the other services telecommunications can provide." (*The Missing Link, Executive Summary*, p.4)

1. Introduction

In 1984, the Maitland Commission, to which I was honored to contribute, noted that telecommunications was a "missing link" in much of the developing world. Ten years later, that statement is still largely true. This paper examines what progress has been made, what problems remain, and the effects of changing technologies and policies. It then proposes strategies to achieve the Commission's goal of bringing the "whole of mankind within easy reach of a telephone " by early in the next century.

2. The Changing Telecommunications Environment

2.1. New Technologies and Services

Telecommunications technology has changed dramatically since 1984. Perhaps the most telling evidence of change is the cover of the Maitland Commission report itself, which shows two rotary dial telephones. This is not to say that digital switching did not exist by 1984, but that it was not considered necessary or perhaps even appropriate for developing regions. A second indicator is that the Commission specifically identified only telephone service, and proposed access "in due course [to] the other services telecommunications can provide." Today, many of those services could be available as soon as telecommunications service is provided.

There are many recent technological innovations that can make telecommunications services more reliable and cheaper to provide. Among the technological changes:

- **Wireless technologies:** Advances in radio technology such as cellular radio and rural radio subscriber systems offer affordable means of reaching less isolated rural customers. These technologies make it possible to serve rural communities without laying cable or stringing copper wire.

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[1]. The author was a special advisor to the Maitland Commission and drafted several of the chapters of the report.

- **Compressed voice:** Compression algorithms can be used to "compress" digital voice signals, so that 8 or more conversations can be carried on a 64 kbit "voice channel, thus reducing transmission costs.

- **Store-and-forward data:** Development organizations seeking cheap ways to communicate with field projects are using single satellite LEO systems for electronic messaging. For example, SatelLife, a nonprofit association of physicians based in Boston, launched a "microsatellite" known as HealthSat in July 1991, that provides store-and-forward data communications to small terminals in developing countries.

- **Voice Messaging:** Voice mail systems can do much more than replace analog answering machines. TeleBahia in northeastern Brazil is using voice messaging technology to offer "virtual telephone service" to people who are still without individual telephone service. They can rent a voice mail box for a monthly fee. Callers can leave messages in their mail boxes, which the subscribers can retrieve from a pay phone. There certainly isn't real time interactivity, but voice mail provides a way for people to communicate in rural regions where postal services are slow or erratic and literacy levels are low. (A similar approach has been used in some US homeless shelters to enable jobseekers to have a way to be contacted by prospective employers.)

- **VSATs:** Small satellite earth stations are proliferating in developing regions, usually for distribution of television signals. However, VSATs can also be used for interactive voice and data, and for data broadcasting. Examples include bank networks in remote parts of Brazil and India's NICNET for government data services. Multiple channels of voice communications can be provided using digital compression (see above). Satellite terminals can also serve as hubs for wireless local networks (see above).

3. New and Changing Demands for Rural Services

3.1. Administration and Information-Sharing

Among the services that new technologies can offer in addition to point-to-point voice communications are:

- **Electronic Mail:** Computer users worldwide may now interact using various electronic mail networks. These services are cheaper than voice communications, and overcome the time zone differences that hinder real time communications. Users may dial into local nodes of packet-switched networks to reduce transmission costs. Specialized electronic mail networks have been established for developing country users (International Development Research Centre, 1989).

- **Computer conferencing:** Another application of computer communications is computer conferencing, i.e. interaction of many users through a central host computer. Participants may log on at their convenience, thus avoiding the need for scheduling to accommodate individual schedules and time zone differences.

- **Electronic meetings:** Managers, development experts, or project staff may now stay in touch electronically rather than having to travel for face-to-face meetings. Audio conferencing allows participants at several sites to participate in the same meeting, while computer conferencing allows for interaction among group members at their convenience by reading and contributing to a discussion stored on a host computer. These electronic meetings do not offer the richness of face-to-face interaction, but they may be particularly important to supplement travel to meetings where transportation costs severely strain limited travel budgets.

- **Data Services:** Data broadcasting via satellite can transmit news or government information to remote locations. Personal computers with modems can access data bases anywhere in the world. Agricultural researchers, for example, may access the Food and Agriculture Organization (FAO) databases in Rome. Health researchers may search the data base of the National Library of Medicine in Bethesda, Maryland.

- **Training:** Audio and/or video conferencing (using video compression to conserve bandwidth) may be used to update field staff without bringing them to the cities for training. For example, in Peru the Rural Communication Services Project linked seven rural communities, three via satellite, and four via VHF radio and then via satellite to the national network. More than 650 audio teleconferences concerning agriculture, education, and health were carried out during the project (Mayo et al., 1987).

- **Distance Education:** Audio conferencing, computer conferencing, and video may be used to reach isolated students who may be studying by correspondence. For example, the University of the South Pacific uses a satellite-based audio conferencing network to provide tutorials to correspondence students scattered in ten island nations of the South Pacific. The University of the West Indies also offers instruction to students at extension centers throughout the Caribbean using a combination of satellite and terrestrial audio links (Hudson, 1990).

- **Electronic Transactions:** Computers combined with telecommunications enable organizations to conduct business from virtually any location. Banks may transfer funds internationally using the SWIFT network (Hudson and York, 1988). Airlines may book reservations from ticket offices, airports, and travel agencies. Brokers and traders may buy and sell coffee, soybeans, copper, petroleum, etc., electronically. With reliable telecommunications links, these activities need not be limited to cities. Agricultural cooperatives may use computer terminals to find where to get the best prices for their crops. Tourist lodges in scenic areas may book reservations.

4. The Changing Policy Environment

In addition to proliferating technologies, we are witnessing proliferating models of restructuring the telecommunications sector in various countries. The major models include:

Ownership:

- **Autonomous Public Sector Corporations:** The first strategy for creating incentives to improve efficiency and innovation in the telecommunications sector is to create an autonomous organization operated on business principles. This often seen as an intermediate step between a PTT structure and some form of privatization.

- **Privatized Corporations:** Privatization models range from minor investments by private companies, to joint ventures between private carriers and governments, to full privatization without any government stake or with a small government "golden share."

Structure:

- **Monopoly:** Most countries began with a national monopoly model that is being eroded. Most maintain some level of monopoly, for example in the local loop, but alternative providers using wireless and fiber are also beginning to challenge the assumption of natural monopoly in the local loop.

- **Open Entry:** An intermediate step between national monopoly and competition is a policy of open entry for unserved areas. For example, the US, Finland, and the Philippines have small companies or cooperatives that were formed to provide services in areas ignored by the national monopoly carrier.

- **Competition:** Competition can range from terminal equipment (now commonly competitive in most countries, including developing countries) to new services such as cellular telephony, to value added services such as packet data networks to full competition in the network.

5. Implications for Planning

Changing rural economies and needs are likely to result in new and changing demands for telecommunications services:

- **Voice and Data:** While basic voice communication is still the first priority, many users now have requirements for data communications as well, particularly facsimile and relatively low speed data communications. Thus transmission channels must be reliable enough to handle data as well as voice traffic.

- **Urban and Rural:** The availability of relatively low cost radio and satellite technologies for serving rural areas makes it possible to reach even the most remote locations, and to base priorities for service on need rather than proximity to the terrestrial network.

6. A Review of Progress

6.1. Telecommunications Growth During the 1980s

To find out what progress has been made in meeting the Maitland Commission's goals, data were collected on telecommunications density (measured in lines per 100 population) in 1980 and 1990. These data are presented in Table 1 and Figures 1 and 2). Countries are grouped according to World Bank criteria, namely:

- Low income economies
- Middle income economies
    - lower middle income
    - upper middle income
- High income economies

For low and middle income countries, telecommunications grew faster than the economy (percent change in telephone lines/100 vs. percent change in per capita GDP).

Low income economies appear to have made significant progress. While their economies grew by only 4.2 percent, telephone density increased an average of 19.7 percent. However, the average telephone density was only .55 lines per 100 population.

Lower middle income economies grew by 12.3 percent on average during the decade, while telecommunications density improved by 53 percent. Yet there were only an average of 5.4 lines per 100 in these countries.

Upper middle income countries showed growth of 23.9 percent in GDP, and 77.9 percent in telephone lines, with density increasing to 16.5 lines per 100. High income economies averaged a percentage increase in GDP of 120.2 percent, and increase in telephone density of 20.9 percent. These data may indicate conditions closer to market saturation.

While the data do indicate progress, the change is discouragingly modest in low income and lower middle income economies. In lower income economies there is an average of only 1 telephone line per 200 people. As these countries tend to have at least 75 percent of their populations in rural areas, it is safe to assume that there are many rural regions in poor countries still without any access to telecommunications. A similar situation is likely to prevail in many lower middle income countries, where there is on average only 1 telephone line per 20 population. Again, since these countries also have a majority of their population living in rural areas, there are likely to be many rural communities without any telecommunications access.

6.2. TVs vs. Telephone Lines

Data are also presented on TV sets per 100 population, with comparable figures for 1980 and 1990. A ratio of telephone lines to TV sets is computed, to provide an indicator of progress compared to broadcast communications access. In all groups of developing countries, television set access grew by more than 100 percent, with growth of 172 percent in low income economies, 221 percent in lower middle income economies, and 169 percent in upper middle income economies. In high income countries, TV sets increased only 17.7 percent, so that there were approximately as many TV sets as telephones. (See Table 1, Figure 1, Figure 2).

In both low income and lower middle income countries, television set access has grown at a rate 4 to 8 times that of telecommunications growth, despite relatively low growth rates in GDP. Part of this growth may be explained by the installation of television transmitters that provide a signal to large numbers of previously unreached people. If this is true, we must ask why there has been greater attention paid to extension of television transmission than in telecommunications.

Another interesting factor is the behavior of people within television coverage areas. It appears that where television is available, a significant percentage of families will find the money to buy TV sets. These numbers indicate a potential pent up demand for other communications services, and the availability of disposable income if the service is deemed important.

Finally, this finding is interesting because generally countries do not have a policy of providing TV access without telecommunications. Television may be highly rated for political reasons as a means of reaching the population, but telecommunications is generally recognized as a critical infrastructure component for economic development.

6.3. Indicators of Entrepreneurship

Another approach to determining whether current strategies for telecommunications investment are somehow missing the mark is to examine indicators of communications entrepreneurship. While comparative data are not available, the following activities in a country would indicate that there are entrepreneurs willing to offer communications services, and customers to support them:

- **kiosks and copy shops**: entrepreneurs who offer communications facilities such as telephones and facsimile services. In countries where this option has not been introduced, entrepreneurs offering photocopying services and/or rental of computers or computer use, desktop publishing, etc.

- **video shops:** shops that rent video cassettes and/or video recorders and players.

- **cable TV systems:** cable TV systems (government authorized or otherwise) that have been installed to provide access to TV channels (e.g. as from a satellite) for a fee.

7. Strategic Implications

7.1. Setting Goals and Targets

Before taking major steps to encourage

investment or restructure the telecommunications sector, planners should set national telecommunications goals. To take developmental needs into consideration goal-setting must involve several government agencies in addition to communications, such as education, health and social services, agriculture, and economic development. This may not be an easy task, as we found in the U.S., because telecommunications and economic development experts don't often intersect, and probably think they have little to say to each other (see Parker and Hudson, *Electronic Byways)*. Since this may be a time-consuming process, and technology does not stand still, planners may need to make some assumptions. For example, nations in general seek to improve educational standards, to provide health care to all, to create jobs, to reduce disparities between haves and havenots, both urban and rural. As we have seen above, telecommunications can contribute to many of these goals.

These general development goals must be translated into specific telecommunications goals, which might include:

- **Universal access to basic communications:** Access may be defined using a variety of criteria such as:
  population: e.g. a telephone for every permanent settlement with a minimum population;
  distance: e.g. a telephone within x kilometers of all rural residents;
  time: e.g. a telephone within an hour's walk or bicycle ride of all rural residents.

- **Reliability:** Standards for reliable operation and availability; quality sufficient for voice, facsimile, and data communications.

- **Emergency Services:** A simple way to reach help immediately, so that anyone, including children and illiterate adults, would be able to call a hospital, police, etc.

- **Pricing:** Pricing based on communities of interest; for example, to regional centers where stores and government offices are located; to other locations where most relatives are located (surrounding villages, regional towns, etc.)

In North America, we have advocated that, in order to ensure that telecommunications technologies and services can be put to optimal use for rural development, the basic goal should be to provide in rural and remote areas affordable access to telecommunications and information services *comparable to those available in urban areas*. The underlying rationale is that universal access to information is critical to the development process.

While planners may want to modify this goal for lower income countries, there is no longer a compelling technological or financial reason to limit rural services. The same technologies that are used to transmit voice can also transmit facsimile and data, and, through digital compression, video as well. AS noted above, access criteria may differ in rural areas, but they may be actually be comparable to access criteria in high density urban areas, where the goal is not to provide a line for every dwelling, but access for everyone through public phones in kiosks, shops, common areas, etc.

It is important to note that this goal is in effect a "moving target": it does not specify a particular technology, but assumes that as facilities and services become widely available in urban areas, they should also be extended to rural areas. Information can be accessed and shared through a range of technologies such as satellite earth stations, microwave and cellular radio links, optical fiber and copper wire. Indeed, the technologies used to deliver the services in rural areas may differ from those installed in urban areas; for example, satellite links and radio networks may be less costly for rural communications than optical fiber or even copper wire.

7.2. Incentive-Based Strategies to Achieve Goals

Next it is necessary to devise a set of strategies to achieve these goals. Strategies are needed to create incentives to increase telecommunications investment, and to drive the investment toward achieving these goals.

Industry Structure:

The Maitland Commission paid little attention to the structure of the telecommunications sector, beyond advocating that telecommunications be set up "as a separate, self-sustaining enterprise, run along business lines." (*Missing Link*, p. 38) At the time, many developing countries were still running telecommunications through a government department with revenues subsidizing the postal services, and often turning foreign exchange earnings over to the national treasury. Today, a majority of developing countries are running their telecommunications administrations as autonomous government-owned enterprises, and many are in the process of privatizing these operations.

Yet, as the data show, a more entrepreneurial national monopoly may not have adequate incentives to invest in facilities to accomplish the goals outlined above, given the unmet demands of business and upper middle class residential customers in the cities. The following are some strategies that can create incentives to invest in rural and less profitable areas:

- **New Services: Franchise or Competition:** The introduction of a new service may be accelerated by issuing licenses for franchises. This approach has been used for cellular radio in Argentina and Mexico, for example. It allows foreign investors with the necessary capital and expertise to provide the service more quickly than it could be offered through the PTT. Satellite services such as data communications may also be offered through one or more private licensed carriers. For example, private banking networks using VSATs have now been authorized in Brazil.

- **Local companies:** Although in most countries there is a single carrier that provides both local and long distance services, it may make sense to delineate territories that can be served by local entities. In the U.S., the model of rural cooperatives fostered through the Rural Electrification Administration (REA) has been used to bring telephone service to areas ignored by the large carriers. Local enterprises are likely to be more responsive to local needs, whether they be urban or rural. An example of this approach in urban areas is India's Metropolitan Telephone Corporation established to serve Bombay and Delhi. Local companies also provide telephone service in Colombia. Cooperatives have been introduced in Hungary. A disadvantage of this approach is the need for local expertise to operate the system, which is likely to be in particularly short supply in many developing countries.

- **Franchises for Unserved Areas:** Another approach to serving presently unserved areas is to open them up to private franchises. Large carriers may determine that some rural areas are too unprofitable to serve in the near term. However, this conclusion may be based on assumptions about the cost of technologies and implementation that could be inappropriate.

It should be noted that wireless technologies could change the economics of providing rural services, making rural franchises much more attractive to investors. For example, while companies such as GTE and US West are selling rural franchises, other companies with a more optimistic assessment of rural profitability are buying them. For example, Rochester Telephone has bought properties in the rural east and midwest. Citizens Communications spent $1.1 billion to buy 500,000 access lines, primarily in the rural western US. And Pacific Telecom, the parent of Alascom, has also recently bought rural properties.

- **Resale:** Third parties may be permitted to lease capacity in bulk and resell it in units of bandwidth and/or time appropriate for business customers and other major users. This approach may be suitable where some excess network capacity exists (e.g. between major cities or on domestic or regional satellites).

Funding:

The question of financing was the subject of extensive debate by the Maitland Commission. Recommendations included giving higher priority to telecommunications by multilateral agencies, including telecommunications in other development projects, and possibly setting aside a small percentage of international revenues for developing country telecommunications (*Missing Link*, ch. 5). One member also proposed establishing an international consortium specifically for telecommunications investment, dubbed WORLDTEL (International Company for Worldwide Telecommunication Development) with an initial capitalization of $500 million (al Ghunaim, 1988). These proposals were not implemented, but the funding environment may be more promising than it appeared a decade ago. Some approaches to funding include:

- **Cross subsidies:** Generally, provision of services in rural areas is cross-subsidized by profitable services such as interurban links. The assumption is that it is important for policy reasons to provide services in rural areas where distance and lower population densities may make services unprofitable.

- **Special Subsidies:** In a competitive environment subsidies must be separately accounted for, so that monopoly services are not used to subsidize competitive services. In the U.S., to further the goal of universal service, the Federal Communications Commission (FCC) has authorized a special universal service fund paid from a portion of pooled long distance revenues. The funds are allocated to particularly high cost areas to keep rates affordable for rural subscribers.

- **Generating Funds for Rural Services:** Policies may be framed to generate funds for other priorities. For example, carriers may charge license fees and/or operate base stations or uplinks for the private networks. They might also require that a percentage of the revenues of these services be allocated to implement other services, such as low cost fixed cellular outlets and thin route telephony via satellite.

- **Aggregating small users:** Rural areas often lack economies of scale that would make provision of new services attractive. In the US, some small telephone companies may aggregate their traffic to provide sufficient demand to attract new services. Another approach to aggregating demand is to provide all government services as well as public services on the public switched network. Government expenditures would then generate revenue to upgrade the public network.

Interim Strategies:

Where telecommunications facilities are not yet widely available, interim strategies may be used to provide at least minimal access to telecommunications services. For example:

- **public telephone service:** installation of publicly accessible telephones where individual lines to businesses and residences are not available;

temporary service: providing telecommunications via satellite or wireless (e.g. fixed cellular service) in areas where permanent terrestrial networks are planned but not yet available. This approach has been used in Eastern Europe;

- **use other media:**
e.g. virtual telephone service: providing

voice mail boxes accessible from public telephones;
videotext: providing one-way textual information for messages and schedules, etc. via television in areas where TV penetration exceeds switched telecommunications access.

Incentives:

Incentive Regulation: Some countries and US states have introduced changes in regulation that allow the carriers considerable pricing flexibility in return for meeting certain conditions (e.g. price caps). An alternative to financial incentives would be a management by objectives approach where policy makers and/or regulators would set objectives and carriers would be rewarded for achieving them. These objectives could include service upgrades such as extension or service to rural areas or meeting quality of service targets.

- **Investment incentives:** Several countries including Indonesia and Thailand have encouraged investors to build new facilities through schemes known as Build Operate Transfer (BOT) where the investors build the system, operate it and receive a percentage of the revenues for a specified period, and then turn it over to the government. Joint ventures may also include incentives for investment in rural areas.

- **Service incentives:** Some countries have encouraged private entrepreneurs to offer telecommunications services. For example, in Rwanda, entrepreneurs may install telephones in kiosks that also sell soft drinks and newspapers. The entrepreneurs receive a percentage of the revenue, and typically stay open much longer hours than post offices, and provide a secure location for the telephone. A similar approach is used in Indonesia.

- **Limiting exclusivity:** While investors may require a predictable industry environment to commit capital, countries must resist pressure to issue indefinite or very long term licenses. The technology and the industry is changing too fast for countries to assume that what seems adequate investment and performance today will be adequate five years -- let alone ten years -- from now. Thus, franchise awards should be for five years or less; and exclusivity agreements should not exceed five years.

7.4. Monitoring Progress

No matter what approach or combination of approaches countries choose to adopt, they must have some way of monitoring progress toward their goals. Incentives have been stressed because most countries do not have the legal history or regulation, nor sufficient available expertise to staff regulatory bodies. However, these countries can establish a small oversight group with the legal authority to require licensed carriers to provide data on the number of lines available, quality of service, sample period traffic data, etc.
A second strategy is for this oversight group to schedule regular opportunities for users to present their needs and problems to carriers. Formal hearings may not always be appropriate, but there needs to be some mechanism for carriers and users to share information, and for regulators to be made aware of user issues and perspectives.

8. Forging New Links

The above strategies embody an extension of the "development-based approach to communication planning" that was implicitly the foundation of the Maitland Commission report. They are designed to reflect the changing technological, policy and financial environments of the 1990s. In particular, they are designed to reflect three themes:

- an awareness that telecommunications goals will be moving targets because of changes in technology and user needs;

- a broadening of the definition of "public interest" beyond the simple assessment of price to customers which is the indicator most often used in industrialized countries;
- an assumption that incentives are likely to be more successful than regulations in encouraging development-oriented investment, but that sanctions must be available if agreed-upon targets are not met.

There is not one standard industry structure nor set of goals that should be imposed on all countries, just as there is not a single technological solution. We must match technological innovation with innovative policies if the Maitland Commission's goal of bringing all of mankind within reach of telecommunications is to be reached by the turn of the century.

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TABLE 1

Indicators: Percentage Change 1980-1990

Country Groups	**GNP/cap**	**Tel Lines/100**	**TV Sets/100**
Low Income	4.2	19.7	172.2
Lower middle income	12.3	53.0	220.9
Upper middle income	23.9	77.9	169.4
High income	120.2	20.9	17.7

FIGURE 1

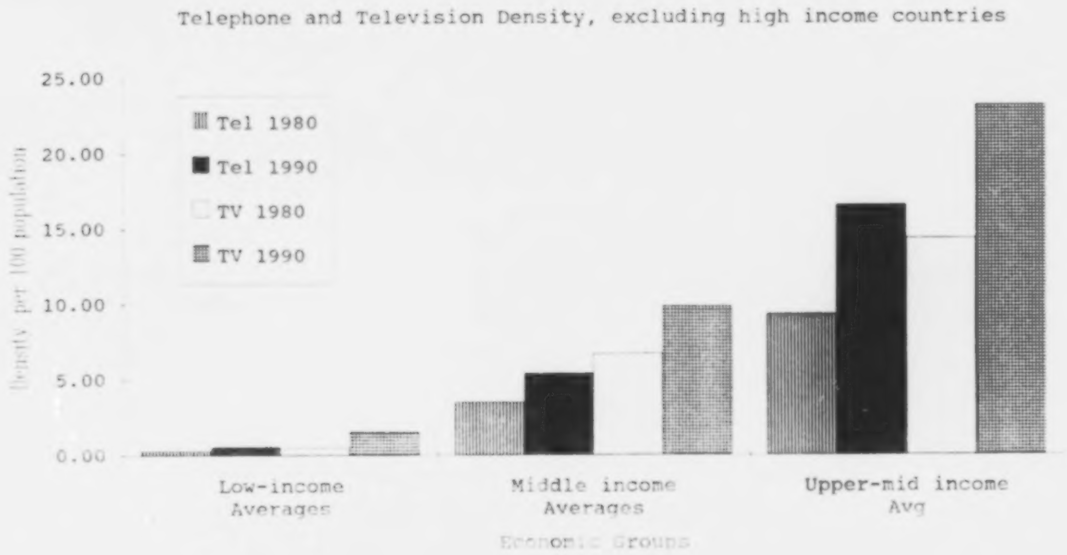
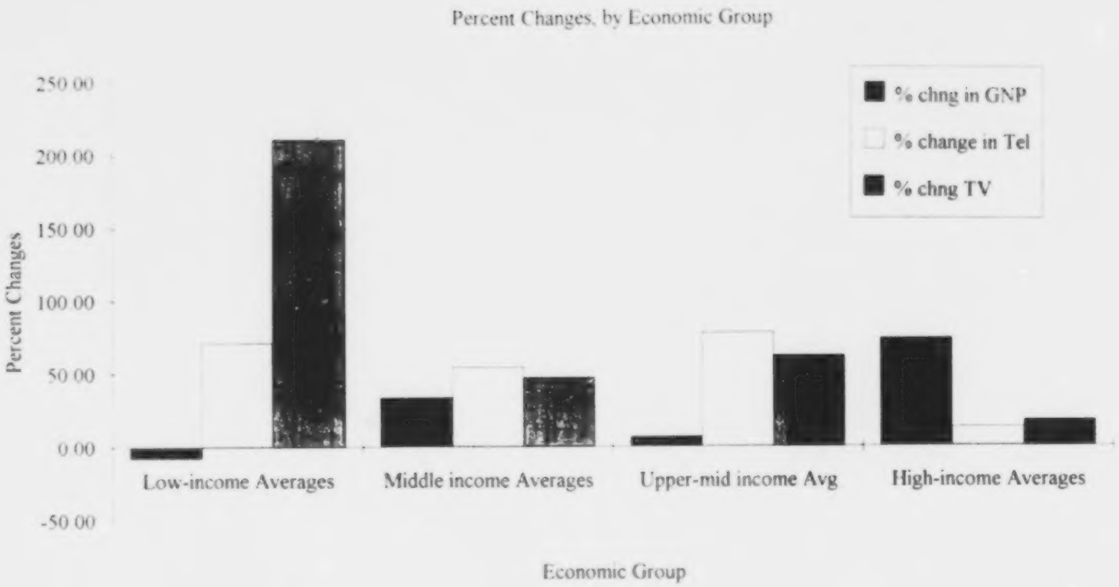


FIGURE 2



Percent Changes, by Economic Group
250.00
200.00
150.00
100.00
50.00
0.00
-50.00
Percent Changes
% chng in GNP
% change in Tel
% chng TV
Low-income Averages
Middle income Averages
Upper-mid income Avg
High-income Averages
Economic Group

PROGRESS IN RURAL TELECOMMUNICATIONS
1984 - 1994 AND BEYOND

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ABSTRACT

Great strides have been made in rural telecommunications since 1984. This progress is discussed in the light of the goals of the Maitland Report and the use of radio technology. Four 'mini' case studies are presented of major rural telecommunications projects and the growth potential for the next 10 years summarized.

1. INTRODUCTION

Providing reliable, quality telecommunications services in the rural areas of the world has never been a simple task. The conclusion can be reached that the reasons for this are not primarily technical or even economic. The Maitland Report of 1984 recognized this and made forthright recommendations which, if not universally adopted, have provided a critical and necessary focus of the issues which would not otherwise have existed.

The Report was a key element in a change in the nature of the debate on "Rural Telecommunications" in both developing and developed countries. Whether providing telecommunications in rural areas is worthwhile or important is now no longer seriously discussed. It is accepted, as it should be, as self-evident - as self-evident as its importance in those countries with fully developed telecommunications networks. The discussion now centres on ways and means, ownership, the choice of technology, timing and so on.

The "overriding objective" of the Maitland Report "that by the early part of the next century virtually the whole of mankind should be brought within easy reach of a telephone and, in due course, the other services telecommunications can provide", was, and still is, extraordinarily ambitious by any standard, but perhaps deliberately so. To have set a more modest goal that everyone could agree was easily attainable would hardly have won much attention or generated much debate, much less motivated serious action. It is for individual countries, regions, districts or administrations to set their objectives at specific levels and establish specific means and specific timetables.

It is not the intent of this paper to examine whether the "overriding objective" of the Maitland Report will be met by the early part of the next century by means of presenting dry statistics and forecasts. Rather its purpose is to review some specific examples of progress over the last 10 years in selected countries within the experience of the authors, to demonstrate the clearly accelerating rate of progress that is visible today and to discuss what progress might take place in the next 10 years.

2. THE PAST 10 YEARS

The past 10 years has seen growing importance placed upon reliable telecommunications with such innovations as direct dialling, 9.6Kbit/sec facsimile and modem links from virtually any subscriber in any other city in the world becoming commonplace. Such ease of communications in rural and remote areas has been slower to arrive, for a variety of reasons, with dramatic progress in some regions and little in others.

Over the last 10 years many reports were issued by the ITU and other organizations which analyzed the economic benefits, reduction of waste, benefit to the environment, etc., of providing reliable communications services. Papers were also published which provided more support to the view that good telecommunications was a major benefit to the economy and general social well being of a country and should be given appropriate priority [Ref.1,2,3,4]. More recently, conditions under which some rural networks may pay for themselves in short periods have been examined [Ref.5].

All the above have helped to establish a clearer vision. Providing telecommunications services to rural regions is an imperative; economically, socially, and politically, and the imperative must be addressed.

In this paper, by way of illustration, 4 examples are given as "mini case studies" to illustrate how some countries have made the appropriate decisions and brought large numbers of their populations within reach of a telephone.

3. 4 EXAMPLES - MINI CASE STUDIES

Four examples are presented here as mini case studies from different regions of the world, to illustrate what has been and what is being achieved. Of necessity, the space available here permits only a brief outline of what has taken place. It should be emphasized that these are only 4 examples. Numerous others could be cited.

In each case Microwave Point-to-Multipoint (P-MP) TDMA (time division multiple access) technology played a major part [Ref.6 (ITU Recommendations)]. This technology has proven itself to be extremely effective for rural regions in terms of

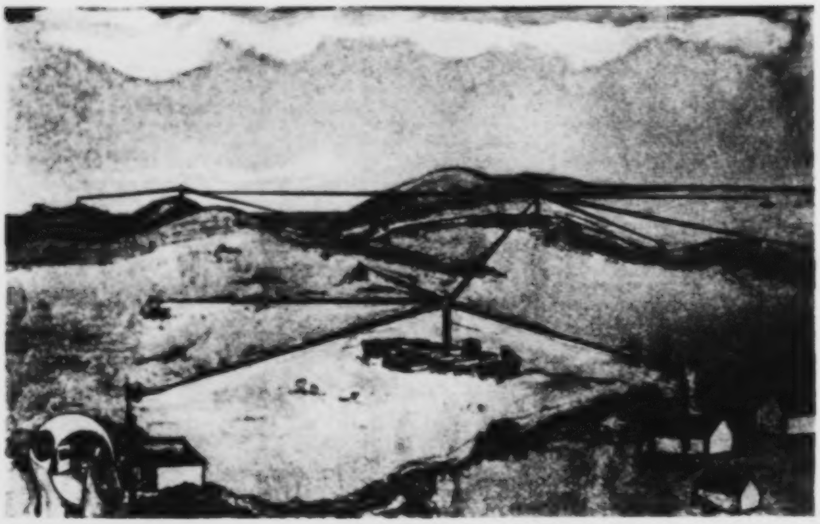

FIGURE 1
ILLUSTRATION OF P-MP TDMA SYSTEM

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reliability, cost effectiveness, performance in the environment and the ability to provide basic telephone service in addition to meeting the technological demands of the future without compromise. Notwithstanding what other technologies are available, P-MP TDMA systems have proven themselves appropriate to the task.

3.1 P-MP TDMA SYSTEMS

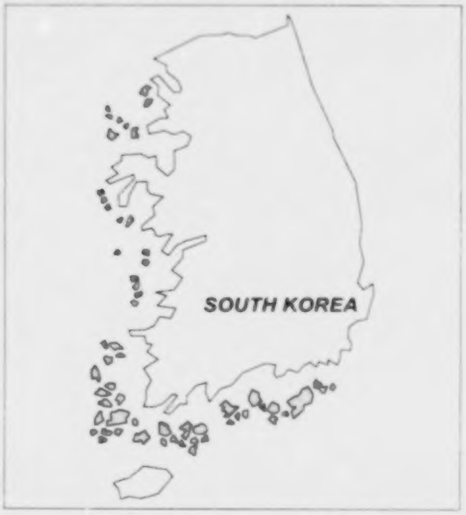
Point-to-Multipoint Time Division Multiple Access systems were designed for the purpose of providing high quality, reliable telecommunication services in rural and remote regions, where the environment can be harsh and access can be difficult. Such systems and their many applications have been described in many places and two selected references are given here [Ref.7,8]. While it is not intended to provide a full description, Fig.1 illustrates how remote subscriber locations are connected into the network. A "central station", normally located near to a telephone exchange, connects into the telephone network and radiates at a microwave frequency in all directions to be covered. Subscriber outstations, to which subscriber telephones or other devices are connected, transmit back to the central station on a single microwave frequency on a time division basis. Access to the radio carrier is demand assigned. Repeaters extend the range of coverage to hundreds of kms.

Voice circuits are CCITT standard 64Kbit/sec PCM encoded, providing optimum network performance and inter-connectability. Data transmission, up to 64Kbit/sec, can be provided in addition to basic access ISDN, when required. Subscriber outstation design is normally optimized to match the number of subscribers at a location which may vary from one to hundreds.

3.2 SOUTH KOREA - THE KOREAN ISLAND PROJECT

South Korea was one of the countries in the vanguard of providing telecommunications to its rural and outlying regions and had, in fact, started a program well before the Maitland Report was published. In their 5th five-year plan covering the period 1982-1986, some $6.5 billion U.S. was invested in their telephone network. While much of this investment naturally went into digital switches and larger centres, a particularly difficult problem to solve effectively was presented by the necessity to provide telephone service to the many hundreds of islands (as illustrated in Fig.2) which surround the west and south coastline on which are located thousands of villages where the primary means of livelihood is fishing. In the 1960's and 1970's, the only telephone service that was available in a few cases was a single channel operator assisted VHF radio which, operating only part-time, could never satisfy the needs of the communities. For very heavily populated islands Point-to-Point microwave systems with a means of local distribution could be used, but for the many less densely populated regions this would not have been economical. Point-to-multipoint TDMA systems however were ideally suited to this type of application, especially since the subscriber terminals could be mounted outdoors, were easily powered by solar panels, and required no on-site attendance or buildings and were easily moved, when necessary.

Of course, when providing service to islands, the only alternative to a radio solution is to provide undersea cables, which for small numbers of subscribers are very expensive to install and maintain.



Shaded Areas - Rural Telecom Service
FIGURE 2

Fishing had grown to become a major industry in the region and demands for telephone service were growing. Furthermore there was a clear need to provide support for medical and educational facilities. A criterion was established that, in this phase of the program, service would be provided to all islands with more than 50 inhabitants regardless of the difficulties in any given case. The aims of the project included: the establishment of a 24-hour highly reliable telephone service with minimum maintenance costs; equalization of quality of service and application of the same tariffs for calls regardless of whether they were from the islands or the mainland.

A 15-trunk 94-subscriber TDMA system was selected and used throughout and ultimately provided telephone service to 511 islands. In the island project as a whole, by 1987 some 67,000 subscriber lines had been installed, ending the isolation of these communities and providing much needed services to the fishing industry and the people in general. Further information may be found concerning the Korean Island project in Reference 9 and a typical installation is shown in Figure 3.

3.3 TURKEY

Turkey is a country with large areas of very 'rugged' terrain; mountainous regions containing many thousands of scattered rural and remote towns and villages. The majority of these towns and villages were without any telephone service in the early and mid 1980's. By government

FIGURE 3
15 TRUNK P-MP TDMA OUTSTATION SYSTEM

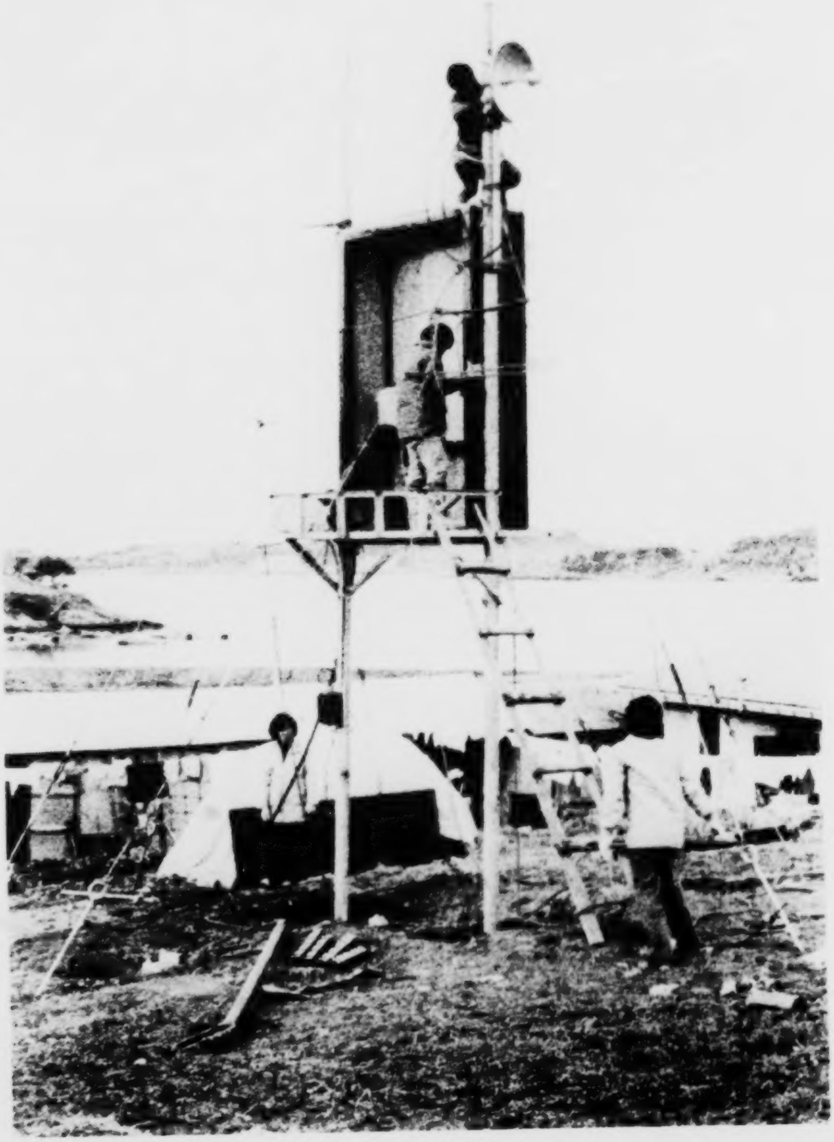
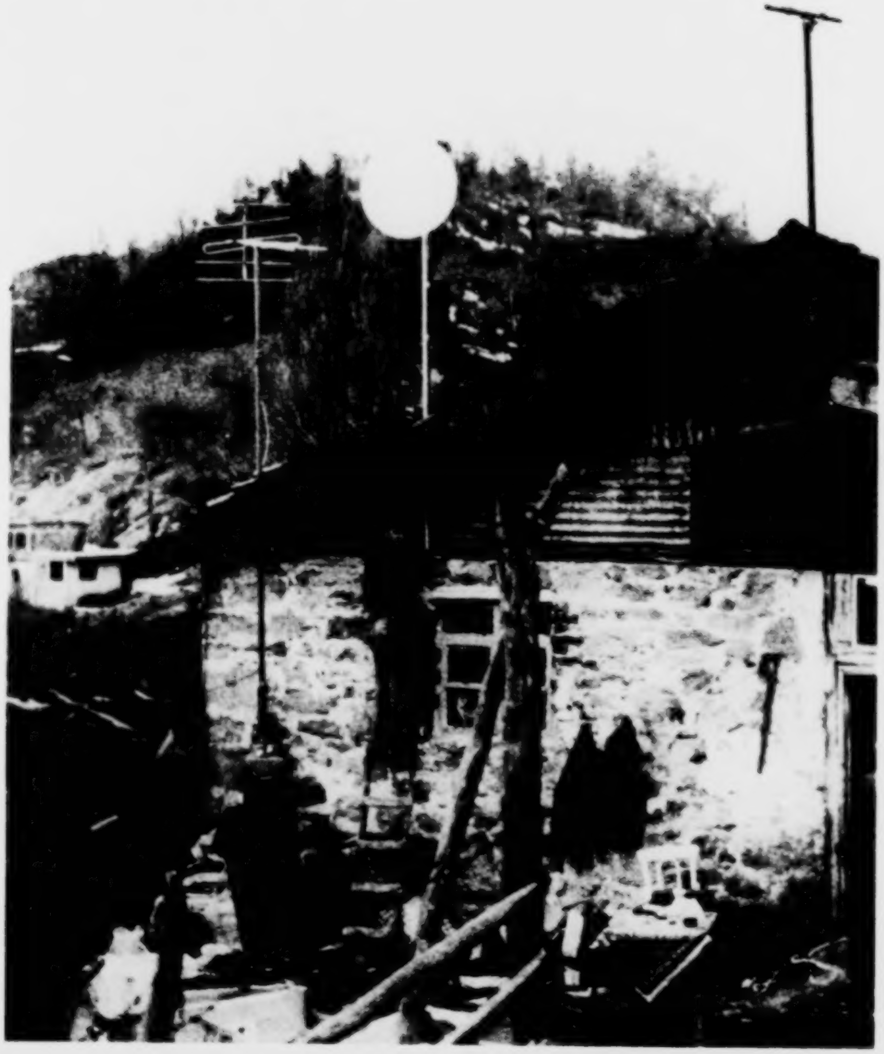


FIGURE 4
INSTALLING AN OUTSTATION ANTENNA IN A MOUNTAIN VILLAGE IN TURKEY



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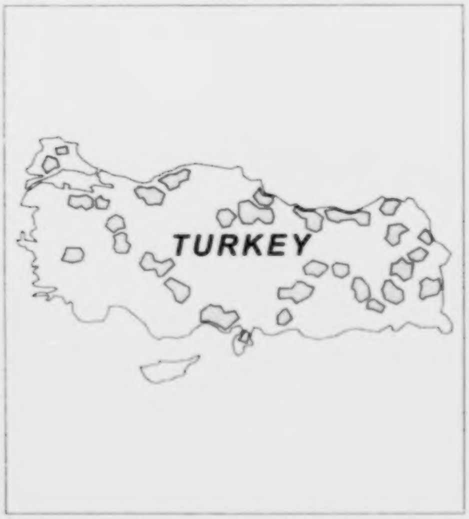
decision, a multiyear program was established to bring telephone service to over 30,000 of these towns and connect them into the national (and international) network. Many of these locations could of course be served by conventional means such as wire and cable, but in a large number of cases - some 12,000 - such means were uneconomical or completely impractical due to the difficulty of the terrain. A radio solution appeared to match the requirement and studies undertaken confirmed this opinion. The plan was to provide a few (typically 1 to 6) telephones in each town, to provide both the public and officials with access to the network in a way that permitted reasonable growth in the future. Given the rugged nature of the region and the difficulty involved in gaining access, especially in the winter, the technology and equipment used had to be highly reliable.

A natural choice to meet these requirements was point-to-multipoint microwave TDMA radio and a 15-trunk system able to provide service to groups of up to 94 subscribers was selected as the product to be used throughout the country.

Since Turkey has an excellent manufacturing base for telecommunications equipment, the project was a good opportunity for manufacturing in-country under license. This enhanced not only the manufacturing capability, but also provided the system operator, the Turkish PT&T, with a local source of technical knowledge to provide long-term maintenance services and ongoing expansions of the network in the future. With these factors in mind, a license agreement was reached between the supplier and a selected local manufacturer. The first few systems were manufactured completely by the supplier to get the project started and the technology was then transferred on a physical basis. The transfer was such a success that within 12 months the TDMA equipment was being built entirely by the local Turkish manufacturer and being delivered to the customer.



▨ *Shaded Areas* - Rural Telecom Project Areas
FIGURE 5

The Technology transfer included a large number of training courses in all necessary disciplines from manufacturing through system planning, design and installation to ensure that the goal of allowing the local manufacturer to operate autonomously could be achieved.

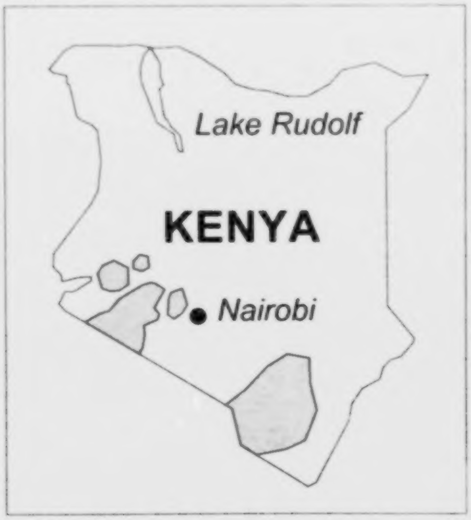
Over a 3-year period, from 1985-1988, some 12,000 towns and villages were connected into the telecommunications network and provided with the highest quality telephone circuits capable of handling both voice and data.

Fig.4 provides an illustration of a typical mountain village site where a subscriber station is being installed. The characteristic horn antenna is mounted on a simple mast on the side of a building. The map in Fig.5 shows some of the areas in Turkey which are now served by P-MP TDMA radio.

3.4 KENYA

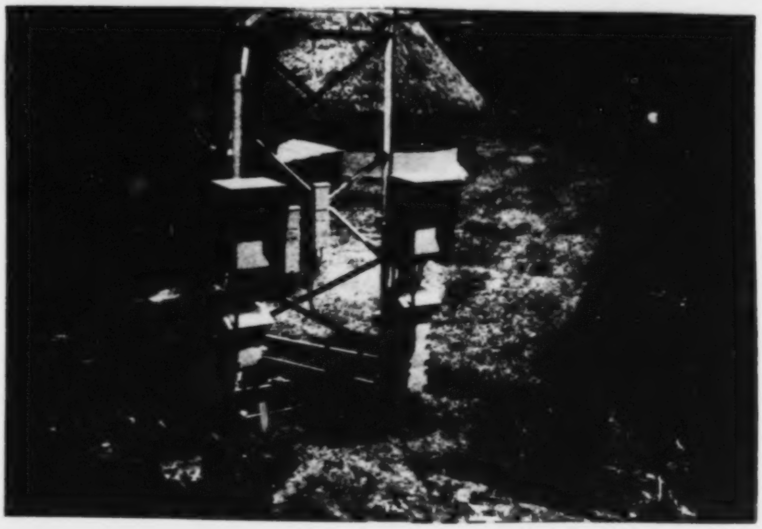
A major rural telecommunications project has recently been carried out in Kenya. This project provides modern telecommunications for the first time in the Lake Nevasha, Masai Mara, Tsavo East and West regions, as shown in Fig.6 and was carried out over the 1991-1993 period. Each area is now connected to the national network of the Kenya Post and Telecommunications Corporation (KPTC). In these regions telephone service is being provided to farms, flower producers, individual towns and villages, payphones, clinics, national parks, tourist facilities, camps and wildlife research centres. The uses to which the new service is put are as diverse as any location in the world.

Several thousand subscriber lines have been installed using P-MP TDMA and in this case a digital 60-trunk system capable of providing service to well over 600 subscribers was found to be the most effective. A typical installation is shown in Figure 7.



▨ *Shaded Areas* - Rural Telecom Project Areas
FIGURE 6

FIGURE 7
60 TRUNK TDMA SYSTEM OUTSTATIONS AT
LONGONOT FARM, KENYA



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Prior to the rural program, modern digital exchanges had been installed in many areas in Kenya. The rural program was then undertaken after a detailed study and analysis of available techniques and products had been made by KPTC.

As everywhere there is much further scope for expansion of the rural network now installed to provide telephone service to many hundreds of additional communities.

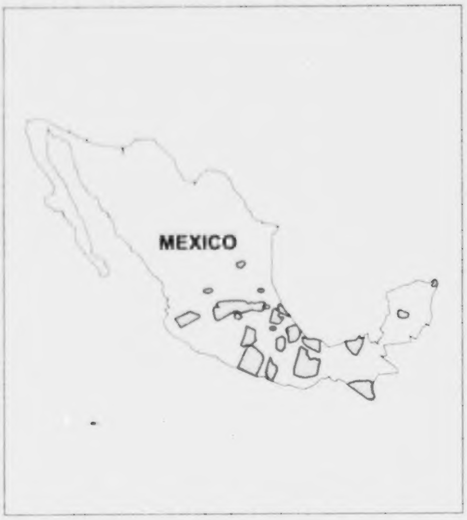
3.5 THE MEXICAN RURAL TELECOMMUNICATIONS PROGRAM

In 1988 Mexico established guidelines for a major rural telecommunications program. By the end of 1993 this ambitious program, one of the world's largest, was well underway with thousands of rural villages connected to the network. The program was developed as part of an overall economic strategy for Mexico established by the government and coincided with major infrastructure development of roads, highways, ports (sea and air) and telecommunications in general. Privatization of many areas of industry, including the largest telephone company, was another part of the economic strategy.

The responsibility for rural telephony development was split between the SCT, Solidaridad (Ministry of Transport and Telecommunications) and owned equally by the federal government and the 31 state governments of Telefonos de Mexico (Telmex). SCT held responsibility for villages with less than 500 population and Telmex for villages with populations over 500. Once SCT had established their rural systems their operation was taken over by Telmex. In this way development of the rural infrastructure in Mexico could be speeded up to the benefit of the citizens.

One of the factors involved in the privatization of the state-owned PT&T and its transformation into Telmex was the undertaking to extend the telephone network into the rural regions and over the course of 3 years bring some 8,000 villages into the network. After appropriate studies, P-MP digital TDMA technology was once again found to be the 'best fit' for the situation and systems have been implemented all over Mexico as shown in Fig.8 by both Telmex and SCT. The magnitude of the task and demanding schedule necessitated the use of equipment from more than one manufacturer. The majority of the TDMA systems used are of high capacity 60-trunk design and a lesser number are 30-trunk. The program is now well underway with thousands of villages now enjoying the benefits of telephone service for the first time. An innovation in many locations was the use of single (or double) line micro-outstations in TDMA systems. These are outstations optimized in performance and cost for the provision of 1 or 2 telephone lines. A typical installation is shown in Fig.9.

In summary, the Mexican rural telephony strategy and its implementation continues to be a great success and outstanding progress has been and will continue to be made in bringing thousands of rural communities into the world's telecommunication network.



Shaded Areas - Part of Rural Radio Network Project

FIGURE 8

3.6 SUMMARY

The above 4 mini case studies all serve to illustrate what has been happening in many areas over the last decade. In each case the factors motivating each country were similar.
- The recognized needs of the rural populations.
- The evident reduction in waste.
- The desire to stimulate economic growth.

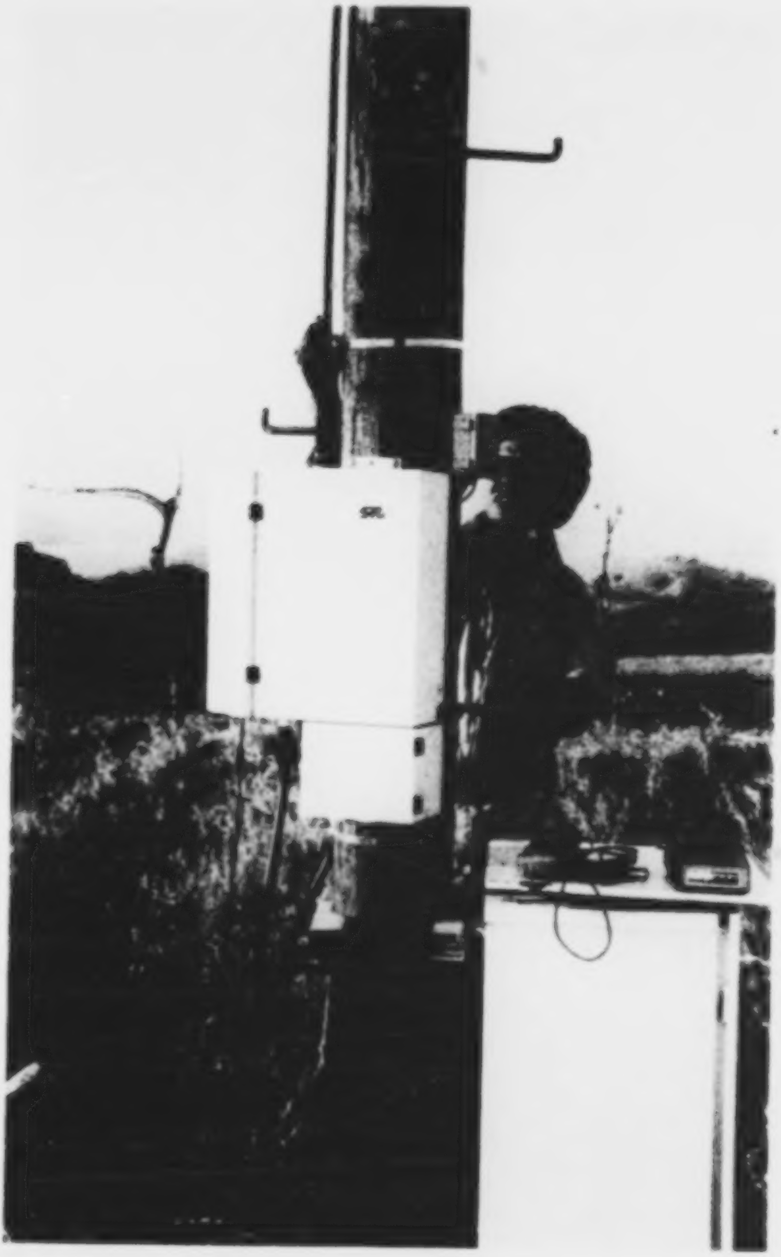
Many other examples of rural development could be cited such as Colombia, Tunisia, Malaysia, Botswana, Indonesia, etc. Despite this huge increase in access to the world's telecommunication network over the last 10 years in rural areas, the greater part of the work still remains to be done, but the fact that great progress can be achieved has now been established beyond all doubt.

4. THE NEXT 10 YEARS

The foregoing are examples of major projects which are providing access to the world's telecommunications networks, for the first time, to many hundreds of thousands of individuals living in rural and remote regions. These projects are the forerunners of the projects currently in the planning stage which will extend telephone service to millions more over the next decade all over the world.

A number of technologies will no doubt contribute in a significant way to the growth of rural networks. Point-to-multipoint TDMA systems have made a major and continuously growing contribution as the technology has developed over the last ten years. The reason for this acceptance is that these systems were designed specifically to meet the tough demands of the rural environment and, at the same time, maintain full compatibility with the fixed telephone network. In

FIGURE 9
INSTALLATION OF A MICRO-OUTSTATION
IN MEXICO



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short, P-MP TDMA systems have proven themselves as "appropriate technology".

Users can look forward to continuous improvements in the technology over the next decade with technical advances being incorporated to make hardware still more cost effective and reliable whilst adhering to the strictest performance standards and full network compatibility. "Spinoffs" from new technologies such as PCS (Personal Communications Systems), once they begin to mature, may be integrated with P-MP systems to further enhance local distribution.

The Maitland Report established a demanding goal for the early part of the next century which will not easily be approached. The work is technically challenging, the size of the task of huge proportions, but it is now clear that real, substantial progress has been made, and will continue to be made on an ever growing scale. In ten years time, the year 2004, the task will still not be complete, but based on what has occurred since the Maitland Report was published in 1984, the situation will indeed have been transformed.

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Worldwide Telecommunications Networks: Development Implications of Investment in the Transitional Economies

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1. ABSTRACT

A recent ITU study has identified three priorities to achieve the Asia-Pacific region's telecommunication potential. This paper applies these priorities (investment, regulatory reform and service development) to the transitional economies of Eastern Europe. Solutions to the problems of the transitional economies are important to the Asia-Pacific. Several of these countries share common borders with the Asia-Pacific Region. Improved communications will increase trade and create new markets.

2. INTRODUCTION

Many of the recommendations of the Maitland Commission's report The Missing Link, were rightly aimed at resolving the problems of developing countries. However, it had been the original intention of the ITU Plenipotentiaries, when they met in Nairobi in 1982, that the recommendations of the Commission should be used "...to achieve a more balanced expansion of telecommunications networks world-wide". The recommendations of the Commission should, therefore, be reviewed in the context of world-wide networks, and not just within the context of the developing world.

The tenth anniversary of the Maitland Commission provides an opportunity to take stock of the progress toward this objective. The situation, as far as the developing countries is concerned has been well documented. In short, while some progress has been made, most developing countries have yet to achieve a satisfactory level of participation in global telecommunications. The Missing Link has not yet been forged.

The recommendations of the Commission were based on the set of conditions pertaining in 1984. Many of these conditions still prevail, including the lack of finances to fund telecommunications infrastructure. This problem, made even more serious by the recent world-wide recession and the overall reduction of donor support from the industialized world, has been compounded by the need to provide resources for new infrastructure in the transitional economies of Eastern Europe.

This paper reviews the principle findings of a recent ITU study in the Asia-Pacific region and applies its conclusions to Eastern Europe, drawing on Ukraine and Hungary as examples. The paper outlines the importance for the Asia-Pacific Region, and for world-wide telecommunications as a whole, of addressing the telecommunications challenges facing the countries of Eastern Europe.

3. BACKGROUND

At the time of the Maitland Commission, in 1984, it was convenient to divide the countries of the world into categories roughly following those defined by the United Nations and the World Bank. Two broad categories, the industrialized and the developing countries, formed a accepted basis, but it was recognized that there were at least two major sub-categories within the latter. The first of these was the newly-industrialized countries which had, by 1984, clearly shown that they had moved beyond the "developing" country definition. The second consisted of those least developed countries which would require special attention in the form of aid and investment. Telephone density, defined as the number of main telephone lines per 100 inhabitants, formed a major element in the Commission's analysis of the situation in these various categories.

In May, 1993, the International Telecommunication Union (ITU) published an analysis of the situation in thirty-nine countries of the Asia-Pacific region. (1) The ITU report noted that the Asia-Pacific region is one of great contrasts. Nevertheless, there is clearly a strong connection between the level of economic development or wealth, and the state of telecommunication network development or teledensity.

Three factors emerge from the ITU analysis which are highly relevant to an examination of the world-wide networks in 1994. First, the dramatic effect which the adoption of the right conditions for growth can have on the transition of teledensity from 10 to 30 lines per 100 inhabitants. Second, the adoption of new categories for analyis (High, Medium and Low teledensity countries). Third, projections showing that low teledensity countries are growing at a slower rate than the regional average, and thus are being left behind.

* Dr. Sklepovy will critique this paper and participate in its presentation at PTC '94

An earlier ITU/OECD report (2) provided a similar analysis of the situation in the former Soviet Union. Similar categories of High, Medium and Low teledensity could be derived from that report. Ukraine, for example, would fall into the Medium density category using this model.

The ITU Asia-Pacific Report concluded that three priorities must be addressed to achieve the potential of telecommunications for the region. These are investment, regulatory reform and service development. The two regions are sufficiently similar that these three priorities can be used as a framework to address the situation in Eastern Europe.

4. INVESTMENT

It has been estimated that $150-200 billion would be needed in this decade in order to achieve a goal of 30 good quality mainlines per 100 population for Eastern Europe generally. (3) The 1992 ITU Report, which covers only the former Soviet Union, estimates that almost 60 million new main lines would need to be added in order to reach a main line penetration rate of 30 main lines per 100 inhabitants by the year 2005. Either way the challenge is daunting, and financing might well be impossible. Clearly, outside investment is crucial if any real progress is to be achieved. Internally generated funds are limited at the outset because tariff levels are low and inflation is high. In some countries, the weakness of the local currency against the hard currencies of the West makes it very difficult to simply purchase new technology.

Following the pattern of the countries of the Asia-Pacific, one would look for evidence of growing investment in the Eastern European countries to move at least some countries as rapidly as possible into the medium or high teledensity category. Foreign investment is taking place, and there appear to be two models.

Privatization:

> The first telecoms privatization in Eastern Europe is taking place in Hungary. The state-owned Hungarian Telephone Company (HTC)is selling a 30% interest which has attracted western interest (e.g. U.S West and France Telecom).

Joint Venture:

> To date joint ventures have been more common. In Ukraine, Ukrainsk Telekomunikasti (UTEL) is a joint venture set up in 1992, involving western partners such as AT & T, PTT Telecom Netherlands and DBP Telekom.

Eastern Europe is drawing investment. However, telecom infrastructure is so crucial to economic development and the transition to democracy that much more is needed. To consider how this might be done, an analytical framework would be useful.

Brzezinski suggests that post-communist transformation can be addressed in three phases. (4) It is only in Phase Two (3-10 years) that he sees the emergence of a legal/regulatory framework for property and business, middle scale privatization and initial foreign investment. In Phase Three (5-15 years) there will be a legal culture, large-scale privatization and major foreign investment.

In general, investment in the telecommunications sector appears to be consistent with this model, and indeed it might be somewhat ahead of the timeline that would be expected. The strategic importance of telecom will probably ensure it is accorded a high priority compared to some of the other sectors. In the case of HTC privatization, one writer observed that Hungary is seen as a good place to show shareholders that risky investments in Eastern Europe can pay off before venturing into more politically unsettled areas like the CIS. (5)

5. REGULATORY REFORM

One element in reducing the risk is the need to establish within the countries of Eastern Europe, clear national goals for telecommunications, sound policies and regulatory structures. The need for such goals is generally accepted, but the appropriate legal and regulatory environment, as a prerequisite for major privatizations, will not happen overnight and can only be expected to emerge as the transition process proceeds.

Investment, and the provision of technology and know-how, short of that which would be achieved through an investor taking a major equity position in a country's telephone company, are required during the transition phase. One of the questions which needs to be asked is how this can be facilitated.

One answer seems to be the Joint Venture approach, probably supported by financing from one or more of the Development Banks. In Hungary, a joint venture between U.S. West and the HTC was awarded a franchise in 1990 to provide nationwide cellular services. The International Finance Company (IFC) provided a loan of $US 15M along with a $US 10M from the European Bank of Reconstruction and Development. The country should have the minimum legal framework that will recognize these types of ventures and protect the interests of the foreign partner(s).

The telecommunications policy of the country may, at the outset have to give a priority to business and/or long distance and international services. It is to be expected that these services will initially be the most attractive to a joint venture. This is where the revenue is most likely to produce a return. At the same time, there will be a need to maximize the technological synergy with the network for public services and for the in-country partner to use profits for the extension and modernization of the network. Governments will have to keep their social objectives in mind as they strive to meet their economic goals.

In the matter of equipment, those countries that are able to establish a design and manufacturing capability for basic electronic equipment will have a major advantage. The availability of a local switch, in the currency of the country, would be a major impetus to the development of local service as it would not require hard currencies. In countries like Ukraine and Russia, where there is a major effort to convert the industries that produced military equipment to meet civil requirements, this is feasible and appears to be moving ahead. Support from the West in terms of technology transfer and or joint ventures in the equipment area could significantly further the telecoms agenda.

Good spectrum management is another important ingrediant for progress. New business services will often be radio-based, and these represent one of the most attractive areas for a joint venture. An important factor for a foreign investor is the assurance that the spectrum will be well managed, and that there is a planning capability to provide additional spectrum to accommodate future growth. This will inevitably require Eastern European countries, particularly those of the former Soviet Union, to take change of their own agendas in the regional and international fora for telecoms and standards. This also applies to satellite organizations, given the potential for mobile satellite services to solve some of the telecommunications challenges.

6. SERVICE DEVELOPMENT

It has become universally recognized that all economies in future will require a basic information infrastructure for commerce and trade. The progress of the Eastern European countries through the transition process will inevitably lead them to establish the basis for this "information economy". Telecommunications is the critical strategic industry to lead in the introduction of this infrastructure. Its inherent profit-generating character ensures that it can contribute to the overall competitive advantage of a country, and it can lead other sectors by providing both self-generated funds and attracting external investment.

The lack of external investment (and the resistance to transfer technologies to the countries of Eastern Europe) should not be interpreted as a lack of faith in the potential of future markets for telecommunications services. Other factors, such as concern with the overall economic or political future of these countries, are more likely to influence investment decisions. Ukraine, for example, is a country larger than France, with a well educated population of over 50 million people. It has a fairly well diversified economy, thanks in part to its broad natural resources. Its needs for telecommunications are virtually axiomatic.

Traditional service development analyses, based on market analyses and business cases, may not be suffient for companies considering entry into the countries of Eastern Europe. A more strategic analysis, incorporating geo-political considerations, is likely to affect investment decisions in telecoms. These considerations are dealt with more fully in Brzezinski's paper entitled "The Great Transformation". (4)

7. GLOBAL IMPLICATIONS

Several countries in Eastern Europe are not likely to have the legal and regulatory frameworks in place for early privatization of their carriers. Nevertheless, it is crucial for their immediate economic development to find ways to at least move forward with the service developments that are crucial to their international and business communications.

Ukraine, for example, has done this with the UTEL Joint Venture. The country's international calling has greatly improved. New digital automatic long-distance switches continue to be installed as part the national telecom network. The use of the joint venture approach to provide other services, possibly radio based, to satisfy the immediate business demand would appear to be an approach worth careful consideration. New terrestrial and mobile satellite-based technologies now becoming available may allow these countries to close the communications gap much more rapidly than could have been envisaged ten years ago.

The need to address the problems of Eastern Europe is important to the countries of the Asia-Pacific regions for several reasons. First, Russia, the largest of these countries, is a Pacific power and is already a trading partner of many of the countries bordering on the Pacific. Other countries are part of the Asian Continent, and share common borders with countries of the Asia-Pacific.

Second, all of the transitional economies are, in the global economy, potential markets for manufacturers and suppliers of telecommunications products and services. Through the medium of Joint Ventures, Asia-Pacific based companies can find new scope and markets for their products.

Third, as trade increases, international traffic to these countries will increase, generating new revenues. Telecommunications can do much to provide the links to encourage international trade and commerce.

Finally, as in the case of Ukraine, many of these countries have skilled resources and could become net donors to the world-wide global network. The potential exists for the transitional economies to contribute skilled human resources and advanced technology to the overall development of worldwide networks.

As mentioned earlier, the ITU has offered a three tier classification of countries in the Asia-Pacific. To a similar three-tier classification in Eastern Europe can be added the broader transitional categories offered by Brzezinski. Those in the "high" category, such as Hungary, are well on their way into transition and can be expected to attract significant investment.

Those in the "medium" category have strong basic resources, but there is still considerable question as to the ultimate outcome of their transition. Here, in addition to early private investment in specific telecom activities, the assistance of western governments is important to assist these countries to develop telecom policies that will attract initial private investment while they are moving toward the phase where privatization can be contemplated.

Those in the "low" category, similar to the LDCs in the Asia-Pacific model, consist of those which have, as Brzezinski puts it "..not even entered [the transition]". Special consideration for development assistance needs to be extended to these countries.

Governments generally can play a significant role in providing government to government policy support and in providing assistance in international fora to help develop the policy and standards environment. As this environment matures, private investment will follow.

Government encouragement of Joint Ventures can provide for a much needed impetus to introduce new services, until the market develops to the point where it can support full tariffs.

8. CONCLUSIONS

The priorities for telecommunications in the Asia-Pacific Region can equally be applied to the transitional economies of Eastern Europe. Investment, regulatory reform and service development are being addressed, but the full impact of the measures being pursued will not be felt for some time. Meanwhile, joint ventures have achieved some measure of success. New radio frequency spectrum technologies are particularly attractive as joint ventures. Solving the telecommunications problems of the transitional economies is important to the Asia-Pacific region. Several of these countries border on the Pacific, or share borders with other Asian countries. Improved communications will increase trade and create new markets for the industries of the Asia-Pacific.

(1) ITU, "Asia-Pacific Telecommunication Indicators", Geneva, May, 1993

(2) ITU/OECD, "Telecommunication Indicators of the Former Soviet Union", Geneva, 1992

(3) Dowler, Rd H. "Rebuilding Telecoms in Eastern Europe", Intermedia, Aug-Sept, 1992, pp 43-45

(4) Brzezinski, Zbigniew. "The Great Transformation", The National Interest, Fall, 1993, pp 3-13

(5) Beck, Ernest. "US West, France Telecom to Bid for Hungarian Stake", Special to the Wall Street Journal, Date unknown.

THE IMPACT OF ACCOUNTING RATE POLICY UPON TELECOMMUNICATIONS CARRIERS IN DEVELOPING COUNTRIES

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I. ABSTRACT

Accounting rates are a complex subject matter with profound implications for the ability of developing countries to fund modern telecom infrastructures. In recent years, the United States has placed enormous pressures upon developing countries to accept lower accounting rates and, ultimately, lower hard currency revenue streams. However, recent data suggest that the growth in the so-called U.S. settlements imbalance may have stopped and that the size of the imbalance may be 50% less than FCC statistics indicate. Further, despite adopting accounting rate benchmarks for developing countries, the United States has failed to develop any empirical basis for criticizing existing accounting rates as being above cost. Nevertheless, U.S.-imposed pressure for lower accounting rates continues to be strong, and telecom carriers in developing countries must consider their options for responding to such pressure. Ultimately, ITU Working Party 3/4 may provide the best vehicle for resolving the competing needs of developed and developing countries with regard to the settlements process. Through multilateral fora such as ITU Working Party 3/4, appropriate recognition can be given to the goal, first recognized in "The Missing Link" in December, 1984, of establishing conditions for all countries to develop modern telecom infrastructures.

II. ACCOUNTING RATES AND THE SETTLEMENTS DEFICIT

An accounting rate determines how much money the carrier which originates a switched international call is obligated to pay to the foreign carrier which terminates the call. Accounting rates are usually specified in currencies such as U.S. dollars, gold francs or special drawing rights (SDRs). The amount which the originating carrier owes to the terminating carrier is typically 50% of the accounting rate. For example, if the accounting rate is $1.30 per minute, the originating carrier would normally owe 50% of that amount, $0.65 per minute, to the terminating carrier. The $1.30 amount is known as the "accounting rate," while the $0.65 amount is known as the "settlement rate."

A new kind of accounting rate, known as a growth-based accounting rate, has emerged over the past five years, sponsored primarily by AT&T. Under this arrangement, the historical accounting rate applies only to the existing level of international traffic measured from a base year, while a negotiated lower accounting rate applies to all growth traffic. Typically, growth-based accounting rates have been negotiated as a compromise between a U.S. carrier such as AT&T, which desires a lower accounting rate, and a foreign carrier in a developing country, which may desire to retain the higher historical accounting rate.

It is important to distinguish accounting rates from collection rates. The accounting rate is established by agreement (i.e., by contract) between two international carriers to govern revenue sharing between those carriers. By contrast, the collection rate is established unilaterally by the originating carrier, pursuant to laws and policies established by its Government, as the charge imposed upon the end user for placing the call. The accounting and collection rates need not be identical. In some cases, the originating carrier may charge a collection rate for calls to a particular country that is lower than the accounting rate with the foreign carrier for those calls. When that happens, the originating carrier will owe more money to the foreign carrier than it keeps from the revenues paid to it by the end user for the call. For example, if the accounting rate is $1.50 per minute but the collection rate is only $1.00 per minute, then the originating carrier will collect $1.00 per minute from the end user, owe $0.75 per minute to the foreign carrier, and retain $0.25 per minute for itself.

International carriers generally do not make payments to each other for individual inter-national calls. Because virtually all carriers both originate and terminate international calls, payments from one carrier to another carrier are made, if at all, only on a net basis. If originating and terminating traffic are balanced evenly between two countries, then each carrier will owe an identical amount to the other carrier and no settlement payments are made. When there is an imbalance between originating and terminating traffic on a particular route, the carrier which originates more traffic than it terminates must make net settlement payments to one or more foreign carriers. Conversely, the carrier which terminates more international traffic than it originates will receive net settlement payments from one or more foreign carriers. (In a few cases where traffic is relatively evenly balanced between two countries, carriers will agree to a sender-keep-all arrangement where no settlement payments are made by either carrier.) Many carriers are net creditors for certain foreign routes and net debtors for other foreign routes.

As between developed and developing countries, the distribution of "net originating" versus "net terminating" countries is not random. Rather, developed countries typically originate far more traffic to developing countries than they terminate from developing countries. As a result, telecom carriers in developed countries generally make net settlements outpayments to telecom carriers in developing countries. Numerous factors explain why developed countries are net originators of traffic and why developing countries are net terminators of traffic:

- disparate levels of economic, technological and educational development;
- disparate levels of per capita income available to use as payment for telephone calls;
- disparate levels of investment in foreign countries;
- cultural and societal differences;
- disparities in collection rates;
- disparities in the distribution and quality of telephones among the population;
- exchange rates;
- tourism; and
- immigration and other demographic factors.

It is the traffic imbalance rather than the accounting rate level that causes carriers in developed countries to make net settlement payments to carriers in developing countries. However, the level of the accounting rate determines the amount of the outpayment for any given traffic imbalance. A higher accounting rate will result in higher net settlement payments to developing countries for a given traffic imbalance, while a lower accounting rate will result in lower net settlement payments to developing countries for the same imbalance.

In the United States, the FCC and certain carriers have viewed the net of all settlement outpayments to foreign carriers as a kind of telecom services trade deficit. According to FCC statistics, the annual U.S. settlements deficit increased from $1.5 billion in 1986 to $3.4 billion in 1991. At one time, the FCC projected that the settlements deficit could balloon to $7 billion annually by 1996. Significantly, the FCC's most recent statistics show that the settlements deficit actually declined slightly to $3.3 billion in 1992. (Table 1 shows the U.S. settlements deficit from 1986 through 1992.) The FCC attributed this fall-off in 1992 to a 10% decline in the average settlement payout per minute from negotiated reductions in accounting rates with foreign carriers. While the size of the deficit is still large as measured by FCC statistics, this unexpected decline could mitigate concern that the deficit is growing uncontrollably from year to year.

In the United States, efforts to scale back the settlements deficit invariably focus upon developing countries. AT&T has estimated that 70% of its total net settlement payments each year are made to carriers in developing countries. AT&T has stated that it has a 3-to-1 traffic imbalance ratio with developing countries, while its traffic imbalance ratio with carriers in developed countries is only 1.4-to-1. AT&T also has estimated that accounting rates with developing countries are on average 50% higher than accounting rates with developed countries. Table 2 lists the current accounting rates for Asia-Pacific countries as well as net settlement payments made by U.S. carriers to those countries in 1992.

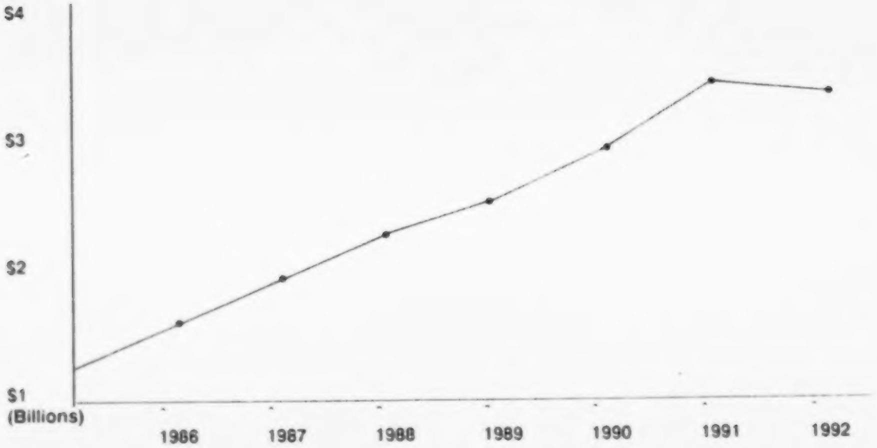
III. THE ILLUSORY SETTLEMENTS DEFICIT: NOW YOU SEE IT, NOW YOU DON'T

For years, it has been an article of faith in the United States that the settlements deficit is a problem, largely caused by foreign carriers, which must be solved through dramatically lower accounting rates across the board. Any service or practice which increased the settlements deficit was immediately suspect, while any service or practice which lowered the deficit was presumptively beneficial. Both the size and growth of the deficit imbued with urgency the FCC's efforts to pressure foreign carriers into lower accounting rates.

New data show that concerns about the settlements deficit have been overstated. As noted in Table 1, the growth in the deficit has apparently halted, as the deficit actually declined slightly in 1992. Similarly, new data are becoming available which show that the size of the deficit is vastly overstated. These data concern the so-called country direct and country beyond services offered by U.S. carriers. Country direct services, such as AT&T's USADirect, treat calls which

TABLE 1

U.S. SWITCHED SERVICES SETTLEMENTS DEFICIT



Source: FCC Statistics

TABLE 2

ACCOUNTING RATES AND NET SETTLEMENT PAYMENTS BY U.S. CARRIERS TO ASIA-PACIFIC COUNTRIES IN 1993

ASIA

COUNTRY	ACCOUNTING RATES	NET SETTLEMENT PAYMENT
Afghanistan	12.69 GF	$137,768.00
Bangladesh	$2.25	$21,816,026.00
Bhutan	2.82 SDR	$93,776.00
Brunei	$2.00	$547,970.00
Cambodia	8.0 GF	$1,680,423.00
China	7.0 GF	$109,188,033.00
Hong Kong	$1.60	$95,784,615.00
India	$2.00	$101,649,378.00
Indonesia	$1.80	$32,978,626.00
Japan	0.95 SDR	$256,373,470.00
Korea	$1.60	$181,269,305.00
Laos	$12.00	$517,780.00
Macau	$2.20	$1,815,591.00
Malaysia	$1.80/1.20	$25,936,451.00
Maldives	$2.50	$227,131.00
Myanmar (Burma)	$5.00	$1,547,536.00
Nepal	$2.00	$1,969,085.00
Pakistan	$2.30	$72,302,144.00
Philippines	$1.68/1.25	$176,636,394.00
Singapore	0.62 SDR	$21,856,077.00
Sri Lanka	$2.20	$6,113,033.00
Taiwan	$1.40	$116,557,920.00
Thailand	$1.75	$47,235,011.00
Vietnam	$2.30/2.00/1.85/1.70	$8,415,811.00
		1,282,649,354.00

Legend

GF = Gold Francs
SDR = Special Drawing Rights
$ = U.S. Dollars

TABLE 2 (Cont.)

ACCOUNTING RATES AND NET SETTLEMENT PAYMENTS BY U.S. CARRIERS TO ASIA-PACIFIC COUNTRIES IN 1993

OCEANIA

COUNTRY	ACCOUNTING RATES	NET SETTLEMENT PAYMENT
Australia	0.6 SDR	$49,688,308.00
Cook Islands	$2.00	$191,824.00
Fiji	$2.50	$4,485,166.00
French Polynesia	$2.50	$2,000,719.00
Kiribati	$4.00	$118,893.00
Marshall Islands	$2.00	$877,392.00
Micronesia		$1,399,046.00
Nauru	$2.00	$30,723.00
New Caledonia	$2.50	$287,405.00
New Zealand	1.0 SDR	$18,807,225.00
Niue	$3.00	$4,699.00
Norfolk Island	$3.00	$6,575.00
Pacific Is. (Palau)	$3.00	$288,938.00
Papua New Guinea	1.5 SDR	$1,139,526.00
Solomon Island	$2.00	$179,522.00
Tonga	$2.00	$3,007,516.00
Tuvalu	$3.00	$24,883.00
Vanuatu	$4.00	$142,560.00
Wallis and Futuna	$2.80	$1,165.00
Western Somoa	$1.50	$723,158.00
American Somoa	$1.40	$4,029,952.00
Guam	$0.80	$10,629,076.00
Midway Atoll	$3.15	$24,171.00
N. Mariana Islands		$3,448,522.00
Wake Island	$3.15	$4,483.00
		$101,541,447.00

Legend

GF = Gold Francs
SDR = Special Drawing Rights
$ = U.S. Dollars

originate in foreign countries as if they had originated in the United States for settlement and billing purposes. Country beyond services, such as AT&T's World Connect service, permit callers in foreign countries to place calls to other foreign countries via U.S. carriers.

By design, the country direct and country beyond services offered by AT&T and other U.S. carriers increase the U.S. settlements deficit. For each minute of country direct service, there is a two-minute increase in the traffic imbalance with the foreign country because the same minute is simultaneously subtracted from foreign-originating traffic and added to U.S.-originating traffic. Similarly, for each minute of country beyond service, there is a two-minute increase in the overall U.S. traffic imbalance as one minute is added to U.S.-originating traffic for both the foreign country where the call originates and the foreign country where the call terminates.

Data on country direct services have only become available in 1993. Under pressure from the FCC, AT&T disclosed that total U.S. country direct minutes represented 10% of all U.S. switched traffic in 1991. Based upon that number, some parties calculated that U.S. country direct services may account for more than 40% of the entire U.S. settlements deficit. (Due to insufficient data, these calculations could not take into account the effect of foreign country direct services or the extent to which country direct services stimulate growth in U.S.-inbound traffic.)

Certain international carriers have come forward with country-specific data. BT has stated that 45% of the traffic imbalance between the U.S. and the U.K. is attributable to U.S. country direct services. Deutsche Bundespost Telekom has disclosed that 83% of the U.S.-Germany traffic imbalance in 1991 was caused by U.S. country direct services.

Perhaps the most interesting data came from the U.S. carrier, Cable and Wireless, Inc. ("CWI"). CWI disclosed that country direct minutes are approximately 20% as large as the entire traffic imbalance between the U.S. and the Caribbean Basin and other regions. By treating country direct minutes as foreign-originating rather than U.S.-originating traffic, the settlements deficit would be reduced by approximately 40% for those regions. Further, CWI's data show that country direct traffic has transformed some routes -- i.e., Bahrain, British Virgin Islands and Cayman Islands -- from those in which U.S. carriers would receive net settlement payments to those in which U.S. carriers must make net settlement payments to the foreign carriers. Table 3 summarizes the data supplied by CWI.

Unfortunately, there is virtually no data available for country beyond services, either on a route-by-route or aggregate basis. However, as U.S. carriers expand these services to numerous countries and market them intensively, they have grown in popularity. One U.S. carrier, IDB Communications Group, Inc., has estimated that at least 10% of the U.S. settlements deficit is attributable to country beyond services. If that estimate is close to the mark, it would mean that at least 50% of the entire U.S. settlements deficit is caused by the country direct and country beyond services offered by AT&T and other U.S. carriers.

Other flaws in the FCC's statistics regarding the settlements deficit have become apparent. First, the statistics deal only with one portion of the costs incurred by U.S. carriers to provide service; they do not show the level or changes in the revenues which U.S. carriers are receiving for their services. Just as one would not prudently assess a business by focusing on costs and ignoring revenues, so the United States cannot reasonably fashion policy by focusing upon the settlements deficit in isolation from revenue impacts and other factors.

Second, the settlements deficit applies only to the switched services of U.S. carriers, not to private line or enhanced services. When new services migrate traffic from switched services to private line or enhanced services, any putative negative impact upon the settlements deficit is only one side of the ledger. In making policy, the United States must view both sides of the ledger by balancing (i) the positive impact upon end users and the private line or enhanced services industry, and (ii) any alleged negative impact upon the switched services industry through a higher settlements deficit.

These data lead to several conclusions. Perhaps most important, they show that whether a service or practice increases the settlements deficit is or should be irrelevant to U.S. policy making. It is accepted without question in the United States that country direct and country beyond services are beneficial to customers and promote the public interest. According to AT&T, those benefits include one-stop U.S. billing, English language operators, and lower collection rates. That these services are beneficial despite causing massive increases in the settlements deficit proves that the deficit should not influence, much less drive, U.S. international telecommunications policy-making. In short, to say that

TABLE 3

THE IMPACT OF COUNTRY DIRECT SERVICES UPON THE U.S. SETTLEMENTS DEFICIT WITH THE CARIBBEAN BASIN AND OTHER REGIONS

COUNTRY	COUNTRY DIRECT MINUTES AS % OF 1992 TRAFFIC IMBALANCE	% REDUCTION IN DEFICIT TREATING COUNTRY DIRECT MINUTES AS FOREIGN-ORIGINATING
Anguilla	22.7%	45.4%
Antigua	26.9%	53.8%
Barbados	1.5%	3.0%
Bermuda	11.0%	22.0%
Cayman	87.1%	174.2%
Dominica	5.4%	10.8%
Grenada	8.7%	17.4%
Hong Kong	21.6% *	43.2%
Jamaica	23.6%	47.2%
Montserrat	9.7%	19.4%
St. Kitts	2.3%	4.6%
St. Lucia	3.8%	7.6%
Trinidad	0.9%	1.8%
Turks	32.8%	65.6%
Tortola (BVI)	67.1%	134.2%
Bahrain	93.0%	186.0%
Yemen	0.7%	1.4%

Source: Comments of Cable & Wireless Communications, Inc., NTIA Docket No. 921251-2351, filed April 20, 1993, App. B.

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* The percentage for Hong Kong reflects 1991 data.

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a particular service or practice should be prohibited because it increases the U.S. settlements deficit has now become a non sequitur.

In addition, the FCC should avoid condemning other services solely for increasing the deficit unless the FCC finds on independent grounds that such services do not promote the public interest. For example, international private line interconnection arrangements into the U.S. public switched network may lead in theory to a slight increase in the U.S. settlements deficit, but they offer benefits which are remarkably similar to country direct and country beyond services -- lower collection rates for U.S. businesses with operations overseas; downward pressure on foreign IDD collection rates; increased transit traffic through U.S. carriers; and increased revenues for U.S. private line carriers. It is difficult to see how the United States can reasonably treat private line interconnection arrangements differently than country direct and country beyond services.

With respect to accounting rates, it is equally clear that the United States must consider factors other than the settlements deficit to identify the U.S. public interest. As noted below, many developing countries rely upon net settlement payments from U.S. carriers to fund infrastructure development through the purchase of equipment manufactured in the United States. Further, a modern telecom infrastructure benefits U.S. investors in these countries as well as U.S. callers who are frustrated today by low call completion rates and inferior quality connections. Ultimately, a modern telecom infrastructure will permit developing countries to improve their economies so that they are more profitable trading partners and have smaller traffic imbalances with the U.S. and other developed countries. It is wrong to assume that net settlement outpayments have no direct or indirect benefits for the United States, and such benefits must be considered when developing accounting rate policies. Further, the broader global interest in ensuring that all countries have modern telecom infrastructures -- first articulated in "The Missing Link" report in December, 1984 -- must be accorded appropriate consideration in the development of any country's accounting rate policies.

For developing countries, these new perspectives on the nature, scope and limits of the settlements deficit over time should reduce -- but probably will not remove -- the pressure from U.S. carriers and the FCC for lower accounting rates. Even if the "real" settlements deficit in 1992 was only 50% as large as shown in FCC statistics (i.e., $1.65 billion rather than $3.3 billion), there still are real monetary benefits to be won by the FCC for U.S. carriers by reducing their costs (in the form of lower net settlement outpayments) through further accounting rate reductions. Therefore, while the United States considers its accounting rate policies in light of factors other than the settlements deficit, developing countries should expect the FCC and U.S. carriers to continue pushing for lower accounting rates.

IV. COST-BASED ACCOUNTING RATES: CAN WE MOVE FROM POLITICS TO REALITY?

The battleground on accounting rates already has already shifted away from the settlements deficit to a focus upon the need for "cost-based" accounting rates. In comments filed with the U.S. Department of Commerce earlier this year, AT&T stated:

> "In determining U.S. policy, it is important to recognize that the absolute level of settlements outpayments is not, in itself, troublesome. . . . Instead, U.S. policy should focus on the above-cost element of the per unit accounting rate (e.g., per minute rates and per message surcharges) that U.S. carriers and their customers must pay to foreign carriers to complete international calls."

AT&T believes that virtually all current accounting rates are above the cost of providing service, estimating that 50% of current net settlement payments from U.S. carriers to foreign carriers represent a non-cost based subsidy.

In 1990, the FCC initiated a proceeding to establish policies for realigning accounting rates with the underlying costs of providing service. In November, 1992, the FCC established so-called accounting rate "benchmarks" of $0.46-$0.78 per minute for Europe and $0.78-$1.20 per minute for Asia and other regions. The FCC hopes that most foreign carriers will agree to accounting rates within these benchmark ranges by the end of 1994 and that all carriers will do so by the end of 1997. The FCC has not ruled out that it might take unilateral action against foreign countries with high accounting rates. Neither has the FCC adopted AT&T's proposal to establish a fast-track 60-day complaint procedure whereby U.S. carriers could invoke FCC enforcement procedures against foreign carriers which resist U.S. demands for lower accounting rates.

The FCC's adoption of accounting rate benchmarks for developing countries was challenged frontally by Atlantic Tele-Network, Inc. ("ATN") in February, 1993. ATN is a U.S. company which owns 80% of Guyana Telephone & Telegraph Ltd., the sole telephone carrier in the Republic of Guyana. ATN argued that the FCC's accounting rates have no empirical foundation, noting that (i) the FCC did not collect, and does not have, the necessary cost data to build a "cost-based" accounting rate from the ground up, and (ii) even if the FCC had complete raw cost data, it has never devised an economic methodology for allocating costs to specific services. ATN believes that the FCC reverse-engineered its accounting rate benchmarks based on the FCC's international trade objective of reducing the U.S. settlements deficit by 50%.

AT&T has acknowledged the absence of publicly available data on the costs incurred by non-U.S. carriers to provide international service, but has suggested that the FCC's benchmarks could be derived from cost surrogates. The FCC itself has not identified such surrogates or disclosed any calculations for deriving its accounting rate benchmarks from surrogates. Further, the only cost surrogates available to the FCC would reflect the costs incurred by carriers in developed countries and could not be used to derive benchmark rates for developing countries. The FCC did not recognize clear distinctions between developed and developing countries, as it applied the same accounting rate benchmarks to developing countries that it adopted for the most developed countries in Asia.

The International Tele-communications Union conducted a study of international traffic costs in 1990, entitled "Follow-Up Study of the Costs of Providing and Operating International Telephone service between Industrialized and developing countries." The ITU Study concluded that developing countries face costs which are an average of 2.08 times higher than the costs faced by carriers such as AT&T. The study also concluded that there was a wide range of costs among developing countries; some countries had costs which were 4.1 times higher than the developed countries with the lowest unit costs. Based on the ITU Study, it is problematic whether any meaningful accounting rate benchmarks can be adopted for developing countries. At a minimum, the ITU Study undermines the use of cost surrogates from developed countries in fashioning benchmarks for developing countries.

There are many factors responsible for the higher unit costs incurred by carriers in developing countries:

- the higher (and sometimes prohibitively higher) cost of capital;

- higher short-term expenditures to build a modern telecoms infrastructure;

- fewer circuit loading and network efficiencies;

- in general, fewer economies of scale and scope;

- higher network maintenance requirements;

- a less highly trained and educated population;

- the absence of a sophisticated economic and technical infrastructure within the country;

- a greater dependence upon transit arrangements and thin, long-haul routes;

- less route diversity; and

- greater contribution requirements.

While some developing countries may have accounting rates which are above cost, the ITU Study and the hands-on experience of carriers in developing countries show that there is no way to tell which accounting rates are above cost, and by how much, just by comparing them to the FCC's benchmarks.

Despite heavy criticism of the FCC's benchmarks, other steps have been taken to increase the pressure upon developing countries to reduce accounting rates to benchmark levels. As ordered by the FCC, AT&T and other U.S. carriers filed progress reports on accounting rate negotiations with foreign carriers on January 1, 1993. In its report, AT&T compiled two lists

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of "problem" accounting rate countries. One list identifies so-called "problematic" countries. The other list identifies so-called "egregious" countries, which AT&T regards as having the worst accounting rate practices. AT&T devised five criteria for these lists: (1) the current accounting rate is more than 100% higher than the mid-point of the FCC's benchmark; (2) the country has not reduced its rate significantly in two years; (3) the level of the accounting rate discriminates against U.S. carriers; (4) the traffic imbalance with the country is greater than 65:35; and (5) AT&T's annual net settlement outpayment to the country exceeds $5 million. Countries which satisfy at least three criteria are placed on the "problematic" list; countries are placed on the "egregious" list when they satisfy at least three criteria and, in AT&T's view, have shown an unwillingness to accept lower rates or to negotiate in good faith. No carrier need satisfy four or even all five criteria in order to be designated as a "problematic" or "egregious" carrier.

Table 4 shows the countries which were included on AT&T's original "problematic" and "egregious" lists. Developing countries appear on both lists and are prominent on the "egregious" list. The apparent purpose of these lists is to impose pressure upon the listed countries to accept lower accounting rates. Implicitly, countries which have been singled out for maintaining accounting rates which are unacceptable to AT&T may feel more vulnerable to unilateral punitive actions by AT&T or the FCC. In July, 1993, AT&T notified the FCC that two countries -- Bulgaria and Trinidad & Tobago -- have been removed from the "egregious" list because they agreed to substantial accounting rate reductions.

In the United States, the pursuit of "cost-based" accounting rates has apparently been a political rather than a technical exercise. No serious effort has been made to assemble pertinent cost data or to develop economic methodologies for constructing "cost-based" accounting rates from such data. The adoption of accounting rate benchmarks and the filing of progress reports by U.S. carriers appear motivated primarily by trade and economic objectives, not by any real concern to develop rigorous criteria for identifying which accounting rates are above cost and, if so, by how much. At the same time, developing countries have not yet articulated their views with the clarity, frequency and unanimity necessary to deflect U.S. pressure for lower accounting rates. As a result, no party has yet captured the high ground in the debate about accounting rate levels.

V. THE IMPORTANCE OF NET SETTLEMENT PAYMENTS TO MODERN TELECOM INFRASTRUCTURES IN DEVELOPING COUNTRIES

The reality is that many telecom carriers in developing countries rely upon net settlement payments from U.S. carriers as a substantial portion of gross revenues and hard currency revenues. For example, Guyana Telephone & Telegraph, Ltd. receives 75% of its total net revenues and 80% of its hard currency revenues from AT&T alone. Any substantial reduction, or even delay, in these payments could seriously injure such carriers, for whom the funds may be necessary for infrastructure development, debt service and even day-to-day operations. In a severe case, it is not impossible that unilateral withholding of settlement payments by U.S. carriers could force a telecom carrier in a developing country to default on its loans or to face insolvency.

The total revenues at stake are substantial. According to FCC statistics (*see* Table 2), U.S. carriers made net settlement payments to foreign carriers in the Asia-Pacific region of $1.384 billion in 1992. This figure represents an increase from net settlement payments of $1.178 billion in 1990 and $1.37 billion in 1991. Implementation of the FCC's accounting rate benchmarks could cause a substantial reduction in the revenues available to virtually all carriers in the Asia-Pacific region.

Unfortunately, many developing countries rely upon settlement payments from U.S. carriers as a matter of necessity, not choice. The equipment and infrastructure improvements which such carriers must undertake often require hard currency. When the native monetary currencies are not readily convertible, U.S. settlement payments may be an essential source of hard currency. In addition, the on-going global economic slow-down has dried up national treasuries in developing countries while limiting the access of carriers in such countries to capital markets. In those circumstances, the cost of capital can become prohibitively expensive for carriers in developing countries, forcing them to fund purchases of essential equipment as well as network maintenance and modernization through (i) the use of settlement revenues, or (ii) the acceptance of onerous terms accompanying supplier (or vendor) credits.

Viewed in isolation from other factors, a reduction in the accounting rate level is almost never the preferred business option of a telecom carrier in a developing country. Lower accounting rates reduce net

TABLE 4

COUNTRIES LISTED ON ACCOUNTING RATE PROGRESS REPORT FILED BY AT&T 1/93

"Problematic" Countries

- Bangladesh
- Belgium
- Brunei
- Cameroon
- China
- Cyprus
- Denmark
- Dominican Republic
- Ethiopia
- Germany
- Greece
- Greenland
- Honduras
- Ireland
- Israel
- Italy
- Ivory Coast
- Jamaica
- Mexico
- Morocco
- Nepal
- Nicaragua
- Oman
- Panama
- Paraguay
- Romania
- Saudi Arabia
- Senegal
- Spain
- Sri Lanka
- Suriname
- Syria
- Tunisia
- Yugoslavia

"Egregious" Countries

- Argentina
- Bulgaria *
- Canada (800 service only)
- Fiji
- French Polynesia
- Guyana
- Iran
- Pakistan
- Russia
- Trinidad & Tobago *
- Turkey

Source: Letter to D. Searcy, FCC, from E. McHale, AT&T (January 4, 1993)(CC Docket No. 90-337, Phase II).

* These countries were removed from the list in June, 1993.

revenues and, possibly more important, reduce hard currency revenues. Lower accounting rates appear to make business sense for carriers in developing countries primarily when they are implemented as part of an integrated multi-year plan involving infrastructure modernization and substantial collection rate re-balancing. In that context, lower accounting rates can be instrumental in reducing collection rates, which in turn can stimulate international traffic growth and maximize carrier profitability. It is usually optimal for infrastructure development to precede accounting and collection rate reductions. It may be unrealistic to expect such reductions to stimulate traffic growth substantially when many developing countries have relatively low call completion rates over current networks.

The problem which many developing countries must face is being asked to accept lower accounting rates before it makes business sense for them to do so. Those countries may believe that resistance to pressures for lower rates will increase their vulnerability to coercion from U.S. carriers or the FCC. AT&T's "problematic" and "egregious" lists have intensified those pressures, which may explain in part why two carriers have already agreed to lower accounting rates in order to be removed from the "egregious" list. Carriers in developing countries which believe that their accounting rates are cost based, but which wish to minimize their exposure to unilateral U.S. actions, may consider other strategies such as justifying the cost basis of their current accounting rate or negotiating growth-based accounting rates. While U.S. carriers may be less willing to accept growth-based arrangements now than in the past, it will be difficult for AT&T to label any carrier which proposes such an arrangement as an "egregious" accounting rate country.

In addition, developing countries may have some basis to resist pressures for lower accounting rates based upon the on-going work of ITU Working Party 3/4. This study group is working to develop an annex to CCITT Recommendation D.140, which favors cost-oriented and non-discriminatory accounting rates for all carriers. The annex would contain guidance on determining the cost orientation of accounting rates. Because neither the FCC nor U.S. carriers have produced data from which to calculate cost-oriented rates or a methodology for doing so, it would seem reasonable for developing countries which believe their current rates are justified to resist premature accounting rate reductions so long as ITU Working Party 3/4 is making progress towards completion of the annex.

There are other reasons to refer the issue of "cost-oriented" rates to a multilateral forum such as ITU Working Party 3/4, at least in the first instance. Pronounce-ments by a single country as to what are, and are not, cost-oriented rates will lack the legitimacy of recommendations made by multilateral fora based upon consensus after all countries have been given a full chance to participate. Particularly given continuing disagreement over measuring and allocating costs, ITU Working Party 3/4 is a preferable forum for a meaningful dialogue among countries on such issues. In particular, the important goal of equipping all countries with modernized telecom infrastructures -- first articulated in "The Missing Link" report in December, 1984 -- is more likely to receive impartial consideration in multilateral fora where both developed and developing countries participate as equals.

It is unlikely that the final results of ITU Working Party 3/4 can be divorced from political or trade influences. There may be no single correct way to measure or allocate costs, and decisions as to the extent of the contribution to be made by international services to a foreign carrier's revenue require-ment involve a delicate balancing of social and economic policies. Nevertheless, the ITU provides a better forum for all views to be adequately represented that the internal proceedings of a single country. While all countries may not agree with the annex ultimately prepared by Working Party 3/4, it may provide a more useful starting point for resolving disagreements about accounting rate levels than the FCC's benchmarks.

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Competition/Cooperation, High Definition Television and the East Asian Newly Industrialized Economies

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1. ABSTRACT

High Definition Television (HDTV) is expected to provide opportunities and threats to the electronics industries of the East Asian Newly Industrialized Economies (EANIEs). Not all of them will be able to get involved in the core technologies and will have to resort to involvement in complementary and ancillary technologies. They will have to cooperate with firms of developed countries to participate fully in HDTV.

2. INTRODUCTION

Radical changes in the world economy have brought new challenges and opportunities to industries and organizations in the United States and elsewhere. Persistent failure of traditional organizations in both home and abroad, have triggered a chain of thoughts among scholars and professionals to reevaluate the basic tenet upon which these industries and organizations have been built.

In order to compete in the electronics industry (more than in any other industry) various involved entities have to be able to internalize specialized capital and resources at a global scale. It is thus necessary for entities to subscribe to either of the two distinct ideal modes of relational dynamics viz. competition and cooperation in the various stages of a product development.

The global intensification of competitiveness in high technology firms has placed an insurmountable burden on firms and players within all industries to coordinate their competition and cooperation to develop profitably new commercial technologies. This has caused academics, business people, and policy makers, professionals, as well as independent agencies, to rethink fundamental ideas about competition and cooperation. This is equally true in the United States because it is losing its capacity to compete and remain an economic superpower in the world economy (Scott, B. R., & Lodge, G.C., 1984). This is leading to a reevaluation of the American institutions and policies. It may be necessary to review some of these policies in the light of new trends in initiating electronics superhighways which is high on the government agenda.

The semiconductor industry is a very good example of this phenomenon. The acute competition to which the electronics industry has been subjected, has made the reevaluation important.

The intense global competition of the 1980s and 1990s has forced many companies in the semiconductor industries to cooperate in R&D. But it has been accomplished only in a piecemeal manner due to existing regulations and practices. Good examples of this new trend in the United States are the Microelectronics and Computer Technology Corporation (formed in 1983), the Semiconductor Research Corporation (formed in late 1982), and the Bell Research (1984) (Stein, A.J., & Das, S., 1988). But these ventures have had minimal support from the U.S. government, in contrast to overseas ventures of other nations. The formation of SEMATECH by the Semiconductor Industry Association (SIA) to develop world-class semiconductor manufacturing technologies with financial support from the U.S. government is an indication of retaliatory measures taken up by the U.S. to recuperate its competitiveness. The role of MITI has implemented similar measures in Japan.

The case study of high definition television is particularly relevant for assessing the present electronic scenario in global markets.

3. HIGH DEFINITION TELEVISION (HDTV)

High definition television is the next generation of television technology being developed by various organizations around the world. (The first generation was monochrome television and the second generation was color television). HDTV promises to bring sharper images to the TV screen, as well as, superior digital stereo sound (similar to compact disc) and a wide screen. But most of all HDTV is a convergence of computer technology and television technology. The forthcoming digital HDTV integrates the available digital technology, display technology, signal processing technology, memory technology, with other technologies that are still being developed in various laboratories around the world.

In 1972, NHK (Japan Broadcast Corporation) drafted a program of study for HDTV to CCIR with 1,125 lines, 60 Hz field rate and 5:3 aspect ratio. The parameters were an outcome of significant contributions to studies of visual and aural acuity as well as specific research on the movement and characteristic of color and eye, psychological effects of the visual field, motion adaptive qualities of the human eye and the effect of sound (Donow, K., 1988). On February 6-7, 1981, NHK demonstrated its 1,125 line system to more than 800 engineers attending the San Francisco SMPTE (Society of Motion Picture and Television Engineers) Conference. NHK had invested a large amount of time, money and honor for their lobbying for their 1125 lines, 60 Hz interlaced standard. That same year, CBS petitioned the FCC for allocation of the 12 GHz DBS spectrum for HDTV system. In Spring 1983, ATSC (Advanced Television Systems Committee) (with a similar mandate as NTSC for color television) was formed with a mandate to explore technology promising to improve the quality of video and, where possible, develop industry standards so the technology could be put to work and in September of that same year, CBS announced its HDTV system that was compatible with the existing television sets, in accordance to ATSC (Broadcasting, September 26, 1983). On March 19, 1985, the HDTV Technology Group of ATSC approved the NHK 1125 lines, 60 Hz, and 2:1 interlaced system. However, there was a major setback to HDTV standardization at the CCIR meeting Dubrovnik, Yugoslavia meeting in 1986. There was a strong opposition to the Japanese standard especially by the Europeans who had their own 1250 lines, 50 Hz, interlaced system (Broadcasting, May 19, 1986). The experience of Dubrovnik illustrated the politicization of HDTV system or in general high technology electronic systems. The electronics industries was facing and is still facing not merely and advancement in technology, but a change in paradigm (Martin, L., 1993).

In the United States the HDTV issue was attracting more and more attention, yet the decision to adopt a standard and implement it was getting more and more delayed. It has been more than 20 years since the first HDTV system was proposed. One common denominating standard that replaces everything in television and movie production is a sales pitch, not a reality (Solomon, R.J., 1990). It seems more likely that the global electronics industry will have to live up with multiple standards. The availability of choices complicates matter further. Thus the decision has not still been made and further delays can be anticipated. The Grand Alliance made up of the final four HDTV proponents of digital system would have to answer and work out many complicated questions about standards and systems of HDTV in the next six months.

4. HDTV TECHNOLOGY

Development of HDTV has been instigated basically by two prime motives. The first was the desire for higher resolution resulting in crisper pictures that could display fine details with rich colors. (The present TV is considered inadequate because it is generally compared to the 35mm celluloid pictures and is considered far inferior). The second motivator was the desire for a wider screen. This would enhance the sense of presence of the viewers thus creating an illusion for the viewer to be more participatory. (With the present TV if the screen width is increased, grains tend to appear causing deterioration of the picture and the wheels of the wagon move backward).

The challenge for the engineers and designers was therefore accommodating these enhancements which required greater bandwidth to accommodate the increment in information. The number of scanning lines, aspect ratio, frame or fields per second called the repetition rate, and the scanning method (progressive or interlaced) are determinants of the bandwidth requirements. (Interlaced scanning is less suitable for computer displays). Interlaced scanning was adopted by the conventional TV system to have a reduction in the bandwidth of the signal.

The bandwidth required and number of scanning lines is determined by the relation $y = f(x^2)$, where 'y' is the bandwidth and 'x' is the number of lines. This relates to squaring the bandwidth with doubling the number of lines. The present 525 lines/60 HZ NTSC system (which uses interlaced scanning) requires 4.2 MHz of bandwidth to accommodate the video signal (which takes into account both the chrominance and luminance signal). Actually, if each of the three primary colors which are red, blue and green are accommodated without any technique for bandwidth reduction 8.4 MHz would be needed for each color. Therefore the total bandwidth would be 8.4 MHz + 8.4 MHz + 8.4 MHz ~ 25 MHz. However matrix encoding of the color signals using phase-encoding reduces the bandwidth to 4.2 MHz. This is a significant reduction. The forthcoming HDTV signal may (the word may has been used, because the final format has yet to be decided upon) comprise 525 X 2 = 1050 lines. This would cause the bandwidth to be squared i.e. 4.2 X 4.2 ~ 18 MHz.

Change in the aspect ratio from the present 4:3 to the proposed 16:9 would increase the bandwidth to approximately 24 MHz. If progressive scanning is used instead of the present interlaced scanning the bandwidth would be doubled to approximately 48 MHz. This bandwidth in eight times the present bandwidth allocated to various television broadcasting stations which is 6 MHz. Without some technique for compression this would be beyond the range for broadcasting. Two separate techniques have been used in Japan and Europe. They are MUSE (multiple sub-Nyquist sample encoding) and MAC (multiplexed analog component) respectively.

The MUSE system reduces the total bandwidth to about 8 MHz, which is suitable for DBS (Direct Broadcast System). The 1125 lines, 50 Hz signal is initially digitally encoded at 48.6 Ms/s (Benson, K.B, & Fink, D.G., 1991). After further processing, the signal controls two comb filters, one responsive to stationary portions of the image, the other to the moving portions. The latter filter is controlled by two motion detectors, one following the outline of the moving area, and other in the direction of motion. The outputs of the filters are combined and the combined signal is again sampled at sub-Nyquist rate of 16.2 MHz. The resulting pulse train is converted to the analog form with a base bandwidth of 8.1 MHz.

The MAC compression scheme readily adapts the 625 line, 50 Hz signals to the requirements of satellite transponders (Benson, K.B., & Fink, D.G., 1991). This method of time compression fits the luminance and chrominance components sequentially in the line scanning time of .064 ms. The sequence of the components is as follows: the second segment of each line scan is reserved for chrominance, but with only one color difference signal (either R-Y or B-Y) (R is red channnel, B is blue channel, and Y is the luminance) per line. This reduces the vertical resolution acceptable relative to luminance resolution. The luminance component occupies twice the chrominance time in each scanned line following the respective chrominance channel. The initial scan time is reserved for the audio channels, sync signals, and other data. The luminance resolution is twice that of chrominance per line. The components are digitally stored sampling luminance at 13.5 MHz and chrominance at 6.75 MHz. After 3/2 and 3/1 time compression their sampling rate is 20.25. The contents are read and converted to analog signal. At the receiver inverse coding process enables information to be retrieved.

Compression and bandwidth reduction is possible by taking advantage of the psycho-visual and statistical attributes of the picture. With proper signal processing considerable bandwidth reduction is possible. Among the attributes are - color resolution perceived by the eye is low, resolution of moving picture as perceived by the eye is low, there is a high correlation between adjacent pixels (both vertical and horizontal) and adjacent frames. Advances in digital compression techniques enables further compression.

The raw data from the camera may contain data rates of the order of 1 giga bps. Taking the above into consideration and combining it with modulation techniques bandwidth compression of the order of 30 to 40 is possible, which would bring the signal bandwidth to that of terrestrial broadcast.

Figure 1 illustrates the basic HDTV system. The video and audio signal is digitized and then encoded. The encoding process bears the greatest responsibility for bandwidth reduction by taking advantages of the attributes mentioned above and removing redundancies by using digital techniques of digital compression. The two signals are multiplexed and sent to the modulator where modulation techniques are used to create a signal suitable for transmission terrestrially i.e. within a bandwidth of 6 MHz. It can be seen that the HDTV system consists of the following components - production - transmission - display. Therefore, sometimes three standardization process are brought about by advocates - the production standard, the transmission standard, and the display standard. Since all of the above are integral part of a whole system, each of them are closely related to one another, and thus one cannot be talked about without due consideration of the other.

Figure 2 illustrates figure 1 using three gray scales which correspond to core technology, complementary technology and ancillary technology in order of their scale of darkness (Ernst, D., & O'Connors, D., 1992).

Core technology, as the name suggests, form the heart of the system. These consists of specific ICs, memory ICs, specific pickup and display devices. This is where proprietary technology is most pronounced. This is from where the individual proponents of the HDTV system are expecting to reap off the most profits. They are also trying to create greater barriers to entry for other firms so that they are able to enjoy the monopoly rents.

There is no clear research for the demand of HDTV yet, but there seems to be numerous potentials in global cinematography, scientific imaging (such as medicine and telephotography), military surveillance and command and control, entertainment industry (especially in sports), and high resolution displays in the computer industry. HDTV seems to open a whole new world of unknown benefis for society. However, they are most speculative.

Complementary technologies are technologies to enhance the core technology. These consists of other ICs, simple memory ICs, and other electric devices. Electronics firms with suitable R&D and investment capital could enter into this market. Individual proponents could not expect to gain a lot from this segment. The barrier of entry in this segment is not very great and therefore no monopoly rent can be expected.

Ancillary technologies are those that do not require sophisticated engineering. These consists of power supply circuits, regulators, simple servo circuits etc. Many electronics firms are already supplying these components and the market is very competitive.

5. HDTV AND POLITICS

In spite of HDTV system being proposed some 20 years or so ago, it seems to be at a distance in the U.S. Why? The reasons are quite simple. They are as follows -

1. The technology was getting more and more complex.

HDTV consists of increasing number of lines and wider screen along with digital audio. This means that a huge amount of information has to be compressed into a very narrow spectrum. Further, digital HDTV has been the center of focus. There have been several proposals that have been placed before the FCC. The complex technology that HDTV incorporates has been beyond the scope of any particular laboratory or company. Laboratories and companies have formed consortia (and now the formation of Grand Alliance) to come out with proposals.

2. The number of players have increased.

The number of manufacturers has grown, the providers are many, the standardization agencies have increased, and the number of consumers have grown. Each of them has an individual position with regard to HDTV. Further, a trend that was initiated by color television, i.e. movement from independent individual inventors to laboratories consisting of many inventors, was stimulated by high definition television. Developments in high definition television carried it to groups of laboratories working together in consortia due to the complexity and capital involvement of the technology.

3. Markets have become global.

The HDTV market is very attractive and the stakes are very high. Many companies from around the world are trying to get a piece of the pie in the HDTV race.

4. There is a shift to digital from analog.

Digital system provides numerous advantages in comparison to analog system. Further with the introduction of digital system open architecture and multiport architecture is being discussed. An ad hoc group Committee on Open High-Resolution Systems (COHRS) consisting of a number of U.S. companies have been formed to explore the various architectural issues.

The analog approach to HDTV is flawed by several factors - it places constraints in extensibility and scalability, it does not take advantage of the powers of computer technology, its resolution is half that of the existing cinemas (specially because the existing analog HDTV systems are interlaced rather than progressive), and there would not be significant savings in post production for films (significant savings have been widely advocated by the HDTV lobbyists). Analog HDTV is just an expanded form of the present TV with digital sound.

5. There are numerous substitute products and complementary products available.

Since the application of HDTV is rather broad substitute products are being threatened. While on the other hand, complementary products could become obsolete. Further, the new HDTV system would have to be compatible with the existing complementary products for it to be successful.

6. HDTV brings in technologies from other fields along with the traditional video and audio technologies. It borrows considerably from the computer industry as well. Some have claimed HDTV to be more computer like than television.

The complexity of the technologies involved in designing a product has paralyzed individual inventors and independent laboratories alike. This situation has been further aggravated by the stakes involved. The situation is more or less "make it or break it." To come out with suitable products, that would gain widespread acceptance in the market, laboratories and organizations have had to come together and cooperate so that resources can be allocated efficiently. Further, the whole of the technology has been undergoing a transition of unprecedented magnitude. It is shifting the electronics base from entire analog to partial digital, and from partial digital to entire digital technology. This has brought about the question of compatibility and interoperability, especially in an age where substitute and complimentary products are ever increasing. Competition imposed in such a situation only causes economic stagnation and deficiency.

The number of players, each having their own agenda, has increased. Each has a particular way of attaining goals, and at times has not ceased to capture the opportunity of deception. The present economy and economic theories are unable to handle and accommodate such a discourse. The situation has further been worsened by the involvement of foreign organizations and participants. This has been a consequence of the movement from local to international to a global market. The traditional ideals of competition, where resource allocation was efficiently handled through competition (which was the sharpest and the strongest economic tool) is no more valid for the pre-product economy stage in today's environment. People have been bringing in and are loudly advocating the concept of the "visible hand" that would be necessary for efficient allocation of resources (Alfred Chandler's "The Visible Hand) (Fransman, M., 1990).

In today's technological environment delays in introducing products and implementing systems, as has been the case with high definition television, means depriving the customer of important advantages. Delay involves stagnation in economic growth and prosperity and inefficient allocation of scarce resources. The delay in technological development and the process of decision making is the consequence of confusion in the understanding of competition/cooperation goal. The trends that have been illustrated above clearly point to a proper approach. In the past, the orthodox ideals may have worked, but today they may not. The old system largely relied on competition as the important, if not the only ideal, but today's environment, the ideal of cooperation is essential.

6. IMPLICATIONS TO THE EAST ASIAN NEWLY INDUSTRIALIZED ECONOMIES (EANIEs)

The largest industry in the world economy at the present is the electronics industry and it is growing faster than any other industry. The application of computer power has further enhanced the situation. Computer based automation and information technologies have transformed industries into organic entities and more responsive to external stimulus. This has created an emergence of highly complex international cooperative networking.

This type of environment has created both opportunities, as well as problems, to the EANIEs. The Development Center of the Organization for Economic Cooperation and Development has identified the EANIEs as Hong Kong, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand (Ernst, D., & O'Connor, D., 1992). The EANIEs have enjoyed most rapid economic growth in recent years. One significant factor for this occurrence has been the dynamic electronics industries and the mode of cooperation as a relational dynamic that they have adopted. The electronics trade has dominated world trade growth and these countries have prescribed to it and have prescribed to it in a very efficient and effective manner.

The EANIEs have had to keep up with the pace of accelerating global technology race and have to face increasingly competitive international environment. The electronics industries in the EANIEs have had to create and destroy entry barriers. Due to increasing costs of R&D and capital intensity, entry barriers in the electronics industries is getting more and more complex and concrete.

The advent of HDTV provides a threat, as well as opportunity to these EANIES. Their share of the HDTV pie will largely be determined by their ability and proficiency of the present electronics industries. HDTV draws in a lot from audio and video technology, communication technology, and computer technology. The present electronic foundation will dictate the starting off platform in the HDTV race.

The place of electronics industries differs widely among the EANIEs. In Hong Kong, Singapore, South Korea, and Taiwan the electronics industry is significantly prominent and forms a large part of their economy. It is extremely important to Hong Kong and Singapore, while it is of lesser importance to Korea and Taiwan. For Malaysia and Philippines it constitutes just about 20% of their exports. (See Graph 1).

The domestic markets for electronics products in these EANIEs differs significantly. Graph 2 illustrates the number of radios, television sets, telephone and personal computers in the EANIEs. Empirical studies have shown that the domestic markets plays a significant role in explaining the growth in a country's industrial output (Chenery, H., Robinson, S., & Syrquin, M., 1986). This is largely due to the economies of scale also. It is also due to the fact that technological adoption in the domestic market creates a synergy for industrial output.

Most of the demands for electronics products are from the OECD countries which is about 90 percent of the total world demand. It is therefore imperative that the EANIEs direct their marketing attention to the OECD countries. With the advent of HDTV this phenomenon will only continue, especially during the early phases of HDTV introduction and adoption.

Production of color television has been a major source of revenue in the electronics industries of the EANIEs. South Korea produced roughly 13 million sets in 1989, which was only one million short to that of Japan (Year Book of World Electronics Data, 1990). Singapore and Taiwan had an output of 910 thousand and 660 thousand respectively. South Korea and Taiwan produces their own color picture tubes. In Thailand, which is the last entrant in the CPT product line, Siam Cement and Mitsubishi, in joint collaboration is expected to produce 1.4 million tubes a year. Hitachi is planning to open a CPT facility in Malaysia. HDTV will require large screens. Though other display technology such as vacuum fluorescent displays, electroluminescent display, light emitting diode displays, passive liquid crystal displays, plasma displays, and active liquid crystal displays are expected to replace the CPT (due to the size and weight of CPTs) in the context of HDTV, it is expected not to occur in the very near future because these display technologies are still quite immature.

VCR production in South Korea and Taiwan is comparable to that of CTV production. In 1989 VCR production in Korea surpassed that of CTV, while in Taiwan VCR production was about 30 percent. With the transfer of VCR production facilities from Japan to Malaysia, it is expected that Malaysia will also become a significant player in the VCR market with a production of about 2 million sets a year. The market for CTV with the introduction of HDTV will sharply increase. Since HDTV promises 35mm cinema quality, audiences will expect to make the maximum of their HDTV sets. With little terrestrial HDTV broadcasting during the early phases of HDTV introduction, the market for VCR can be expected to parallel HDTV sets. The technology will not be the same however. The present VCR tapes are built to accommodate less amount of information than that of HDTV signals. The core technology, that will consist of special purpose ICs and memory ICs will be at the disposal of key manufacturers of OECD. To avail these technologies, firms in the EANIE will need to form cooperative agreements with these firms. The complementary technology, consisting of amplifying circuits, filter circuits, etc. will however not change dramatically. Therefore, these firms in the EANIEs will be able to take advantage of it. The ancillary technology will remain the same. Since the present VCR will be substituted with the HDTV VCRs these firms can expect to enjoy the same profits.

In Hong Kong, Singapore, and Malaysia audio equipment is more important than video products. However, audio component production is the highest in South Korea, followed by Taiwan and Hong Kong. Singapore is only a few steps behind. HDTV promises CD quality sound. The demand for high quality audio equipment can only grow with the introduction of HDTV equipment. Since the audio technology is fairly well established, and no new enhancements are expected in the technology itself with the introduction of HDTV, these firms can be expect to further their profits significantly.

Taiwan and Singapore are the largest EANIE producers of office automation equipment (consisting of microcomputers, computer monitors, and computer terminals) which is of the order of $4.5 billion. They are followed by South Korea, which is of the order of $2.7 billion. Singapore is more concentrated on disk drives than other components. There are considerable foreign firms assembling in Singapore such as Apple and Compaq. Thailand is also developing its office automation equipment industry. Many foreign firms are relocating from Singapore to Thailand (such as Seagate Technology) and a number of Japanese firms are opening new facilities in Thailand (such as Minebea). Malaysia has also started attracting many foreign firms, especially from Singapore. Since HDTV is the convergence of computers and television demand of computer technology is expected to grow. However, HDTV will involve within its system special purpose ICs and memory ICs. This generally falls within the realms of core technology. It is therefore imperative for these firms in the EANIEs to either direct their attention to IC designs and fabrication or they will not be able to actively participate in the HDTV market. Forming cooperative agreements with other firms within the EANIEs or with firms in the OECD might be the only avenue that these firms in the EANIEs can expect traversing in order to be successful.

Hong Kong, South Korea, and Taiwan are major producers of communication equipment. South Korea has a very dynamic switching equipment industry (about $1.8 billion). In Hong Kong and Taiwan, terminal equipment are overwhelming. With firms such as Motorola, Malaysia has a large share in the communication equipment industry. Indonesia's communication equipment base is roughly half that of Malaysia with concentration in satellite systems. Thailand has become a large producer of telephone sets for AT&T. Even though the introduction of HDTV will affect the communication equipment industry, the EANIEs firms cannot expect to be active participants in this sector because the type of communication equipment that these firms are manufacturing will not have any consequence on the HDTV market. HDTV will require new transmitters that can broadcast digital signals which will incorporate core technologies that only the proponents will possess and will use it to reap off monopoly rents from it. Therefore, the EANIE firms can be expected to be excluded from this sector. The EANIEs might expect to fill in with complementary technologies and ancillary technologies, but the market will not be significant.

South Korea is the largest EANIE supplier of semiconductor components of which ICs form a major portion which is about $3.6 billion. Malaysia is the second largest followed by Singapore. Singapore is shifting it attention to wafer fabrication and IC design. Taiwan is a significant supplier of ICs, but most of it is assembly only. Thailand and Philippines is an assembly base. Demand for ICs will be enormous with the introduction of HDTV. Both special purpose ICs, as well as generic ICs, will be in great demand. HDTV is expected to be highly IC hungry. There is no way to make HDTV sets withouts incorporating the most advanced microprocessors and silicon memory galore. Thus even though these firms in the EANIEs can expect to profit a great deal with their supply of generic ICs, it might be necessary to form cooperative agreements with the OECD firms to come out with special purpose ICs so that they may be able to contribute to the HDTV market significantly.

Taiwan leads all EANIEs in passive components production which is about $1.6 billion. It is followed closely by South Korea. The production of Hong Kong and Singapore is about half that of Taiwan. Malaysia is rapidly developing it production. Since HDTV will be substituting the present TV and VCRs, the market for passive components will only have a shift effect. Therefore, not a great deal can be expected in the segment.

7. CONCLUSION

At present various cooperative efforts in the electronics industries are aimed at sharing R&D expenses and pooling of resources, especially for the development of generic technologies (BlackBurn, J.F., 1990). However, most firms in the EANIEs lack the technological capabilities to share the burden of R&D and reap profits. Therefore, in most of the EANIEs foreign direct investment (FDI) has traditionally played an important role as a vehicle for international electronics technology sourcing, contrary to their will of cooperative efforts. FDI growth by Japanese firms in these EANIEs has been significant during these past few years. Of the $10.2 billion investment by Japanese firms until 1988 almost 30 percent was directed to these EANIEs (Urata, S., 1990). The U.S. FDI investment in the EANIEs is also significant. Japanese investment clearly dominates U.S. investment in Korea and Thailand, while U.S. investment dominates Japanese in Singapore, while in Taiwan and Malaysia, both Japanese and U.S. investments are quite balanced (Ernst, D., & O'Connor, D., 1992). In Philippines and Indonesia FDI from both these countries are generally small with U.S. dominating in Philippines and Japan dominating in Indonesia.

The FDIs have enabled these EANIEs to avail some technological spillovers from it, generally from the transfer of skilled personnels, parts and suppliers networks, and user-producer linkages. This has proven to be one of the most powerful tools in the method of technology acquisition. With this method at hand, some of the firms in these EANIEs are deciding on whether and to what extent they need to develop their own electronics industries and how to vertically integrate it, as well as diversify it.

Further, new and recent development in information technology have opened up new possibilities for coordinating actions and transactions - both intra and inter companies and intra and inter nationally. As a result, increasingly dense networks have emerged for the exchange of scientific knowledge, generic technologies and marketing intelligence which have been called "the most ubiquitous mode" of current globalization trends (OECD, 1990). The EANIAs have not hesitated to reap the benefits availed from this new development. This has been a catalyst to the cooperative agreements which has been regarded as the strongest competitive tool in the electronics industry where high technology is the prime mover.

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Cooperative agreements in the electronics industries was originally pioneered by European and Japanese companies (Ernst, D., & O'Connor, D., 1992). Europeans, due to necessity, and Japanese, due to culture and history. In Europe, companies like Philips and Siemens perceived them as a vehicle for catching up with US technological and market leadership. Japanese firms, since the mid-1970s, have also used cooperative agreements as an instrument of catching-up strategies. The benefits of cooperative agreements as identified by Ernst and O'Connors is - burden sharing, market access, access to finance, access to other key factors of production, and influencing the determination of standards. However, benefits and not limited to these only. Other factors such as global trade barriers have also dictated the trends towards forming cooperative agreements and strategic alliances. However, cooperative agreements with the EANIEs would not be an attraction if technological dissemination was the only consequence. The EANIEs firms sometimes possess complementary assets and strengths such as large cash reserves, control of domestic markets, favorable government regulations and incentives, etc. This is the reason why some companies have instigated and adopted cooperative agreements with some firms of the EANIEs such as Goldstar Electron Co.'s tie up with Hitachi to produce DRAM, Intel's tie up with Samsung, Acer's tie up with Texas Instruments etc.

Among the EANIEs, Korea has developed the most competitive electronics industry which has been largely due to the consequence of *cheabol*. While historically based on low manufacturing costs, it needs to further its technology to overcome the rising costs of manufacturing if it is not fall behind in HDTV technology. Singapore and Taiwan have shifted their attention from consumer electronics to office automation. Hong Kong has concentrated it's effort in low end electronics products such as video games, watches etc. Malaysia and Thailand have developed as competitors in consumer electronics, but most, if not all, of their firms are FDIs. Indonesia is a few step behind but is rapidly catching up.

It seems that very few of the EANIEs firms will be able to acquire and manufacture the core technology for HDTV. South Korea seems to be the most promising in its ability to acquire and manufacture core technologies for HDTV. The remaining EANIEs firms will only be able to acquire and manufacture complementary and ancillary technologies for HDTV, the market of which will also be significant. New firms can be expected to come into existence, while some old firms may fade to extinction. HDTV provides both opportunity, as well as threat, to the electronics industry of the EANIEs.

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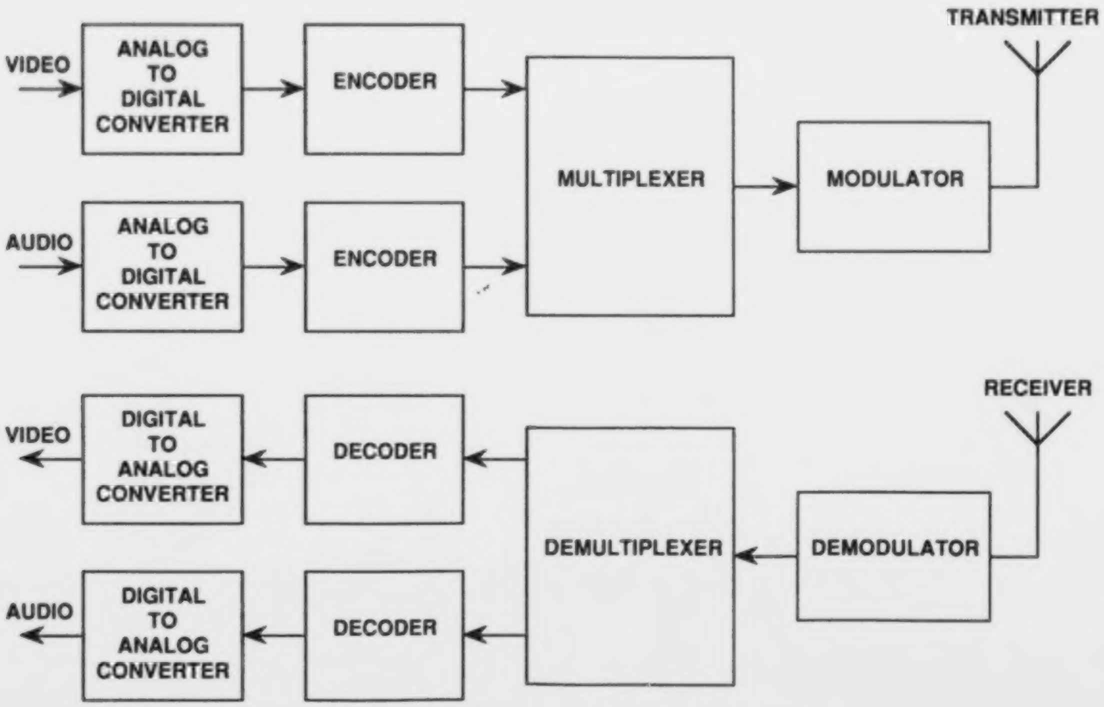
TRANSMITTER
VIDEO
ANALOG TO DIGITAL CONVERTER
ENCODER
MULTIPLEXER
MODULATOR
AUDIO
ANALOG TO DIGITAL CONVERTER
ENCODER
RECEIVER
VIDEO
DIGITAL TO ANALOG CONVERTER
DECODER
DEMULTIPLEXER
DEMODULATOR
AUDIO
DIGITAL TO ANALOG CONVERTER
DECODER

FIGURE 1. HIGH DEFINITION TELEVISION SYSTEM

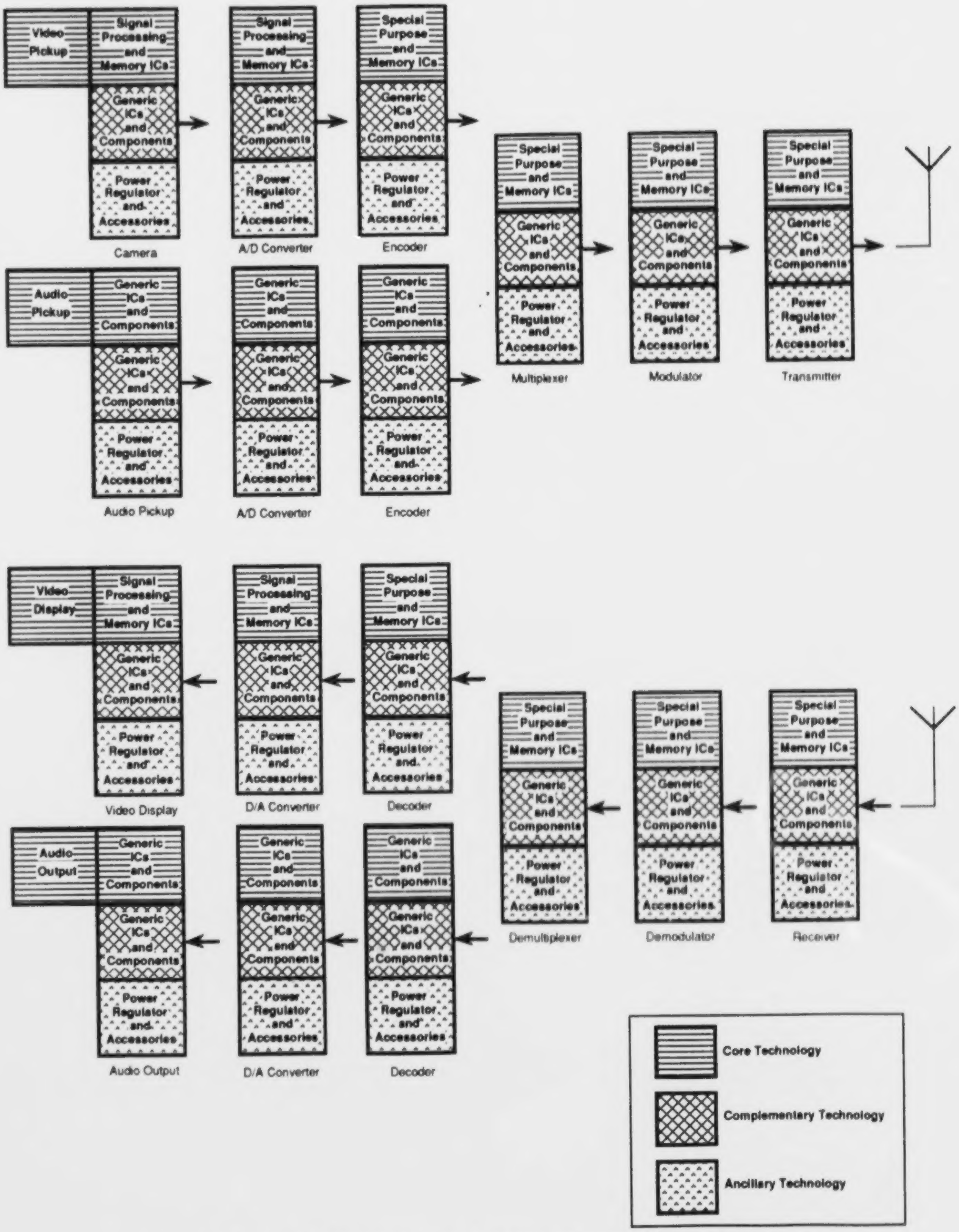
Video Pickup
Signal Processing and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Camera
Signal Processing and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
A/D Converter
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Encoder
Audio Pickup
Generic ICs and Components
Generic ICs and Components
Power Regulator and Accessories
Audio Pickup
Generic ICs and Components
Generic ICs and Components
Power Regulator and Accessories
A/D Converter
Generic ICs and Components
Generic ICs and Components
Power Regulator and Accessories
Encoder
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Multiplexer
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Modulator
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Transmitter
Video Display
Signal Processing and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Video Display
Signal Processing and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
D/A Converter
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Decoder
Audio Output
Generic ICs and Components
Generic ICs and Components
Power Regulator and Accessories
Audio Output
Generic ICs and Components
Generic ICs and Components
Power Regulator and Accessories
D/A Converter
Generic ICs and Components
Generic ICs and Components
Power Regulator and Accessories
Decoder
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Demultiplexer
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Demodulator
Special Purpose and Memory ICs
Generic ICs and Components
Power Regulator and Accessories
Receiver
Core Technology
Complementary Technology
Ancillary Technology

FIGURE 2. HIGH DEFINITION TELEVISION TECHNOLOGY CLASSIFICATION

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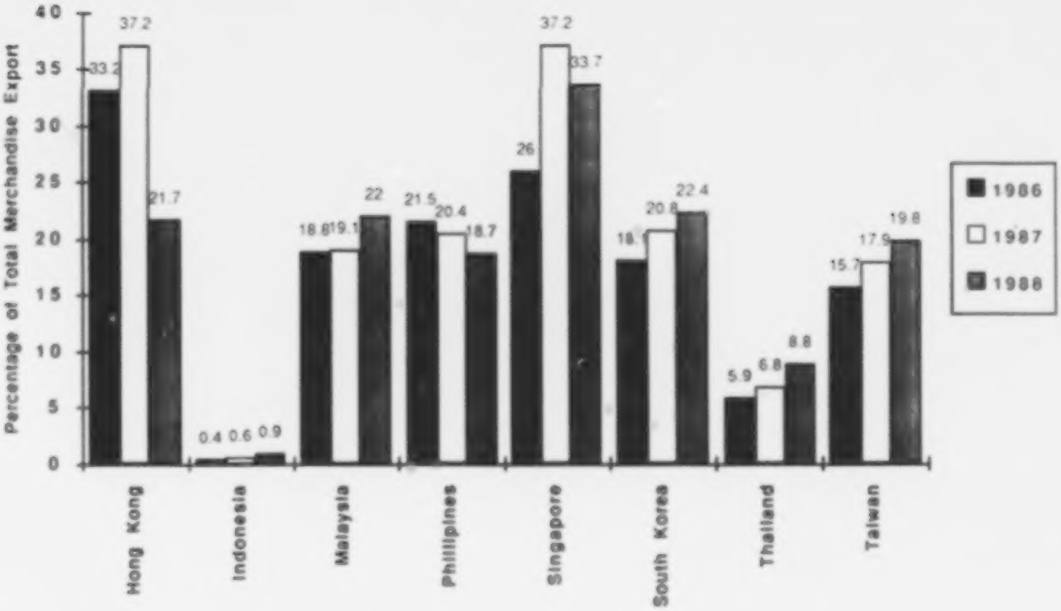
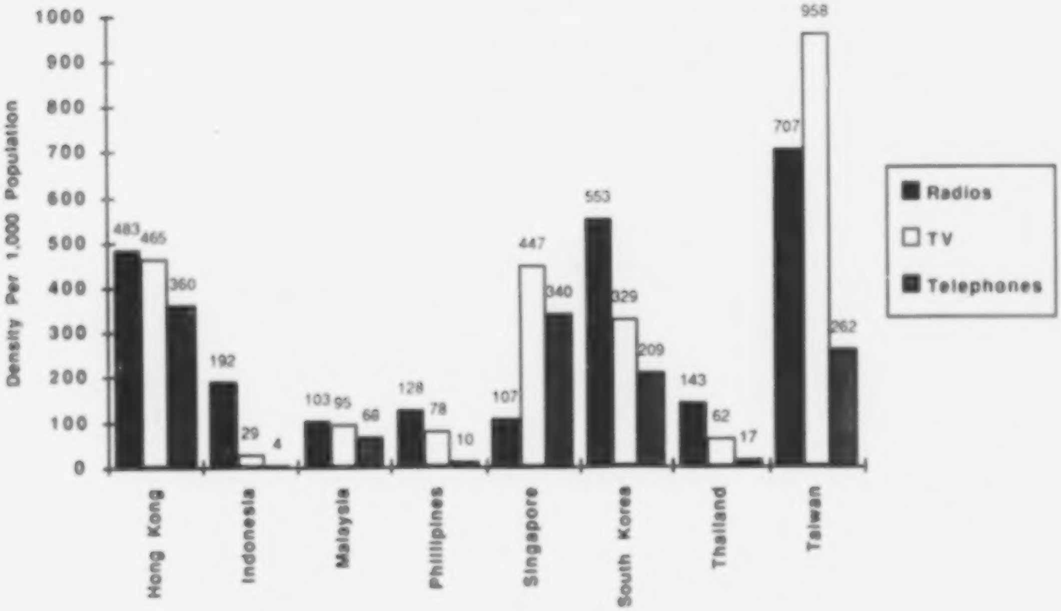


GRAPH 1. PERCENTAGE OF TOTAL MERCHANDISE EXPORT
SOURCE: HANDBOOK OF INTERNATIONAL TRADE AND DEVELOPMENT STATISTICS 1988, UN



GRAPH 2. DOMESTIC MARKET FOR ELECTRONIC EQUIPMENT (1987)
SOURCE: YEAR BOOK OF WORLD ELECTRONICS DATA 1988

Operator Privatization Versus Other (Better?) Methods of Restructuring in Developing Asia-Pacific Countries

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1. ABSTRACT

Privatization is of two types: stockholder privatization and operator privatization. In operator privatizations, bidders typically indicate by the prices paid that they expect to extract hidden value from the privatized PTO. This expectation has a range of practical consequences, including fixing readily solved problems, a focus on cost reduction, job exportation, access to dual margins, and providing special advantages to gain MNC traffic. Because some of these consequences are less than desirable, Asian countries should be sure to consider alternatives to privatization that may have better overall outcomes.

2. DEFINITIONS

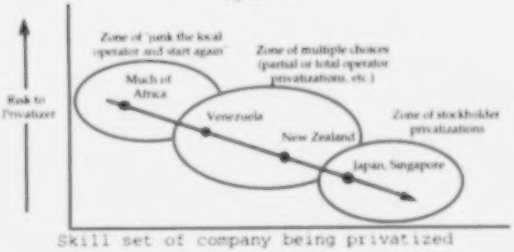
This paper analyzes key issues with regard to what we refer to as an operator privatization. While there are many variations on privatizations, the two main kinds are:

- Stockholder privatization, where the government sells shares of the PTO on the domestic and international capital markets. Such a privatization may be done in stages—as in the U.K. with BT and Japan with NTT—or may be done all at once. The government may retain shares. However, in most if not all cases shareholding is widely dispersed and no single entity, especially a foreign PTO, can exercise effective let alone actual 50%+ control.
- Operator privatization where the government sells part or all of the indigenous PTO to a foreign PTO, or as is in fact the norm, to a single consortium that blends foreign PTOs with a local partner(s). New Zealand did a 100% sale to a consortium of Ameritech and Bell Atlantic. Venezuela did a 40% sale to GTE plus partners including AT&T, but the GTE consortium has effective control—subject to much interference—of the Venezuelan phone company, CANTV.

3. OVERALL "THEORY OF THE CASE"

As noted above, there are many variations in privatizations. However, CSMG has observed a risk versus skill set group of relationships that will help form a backdrop to any analysis of privatizations:

Figure 1


Zone of 'junk the local operator and start again'
Zone of multiple choices (partial or total operator privatizations, etc.)
Zone of stockholder privatizations
Risk to Privatizer
Much of Africa
Venezuela
New Zealand
Japan, Singapore
Skill set of company being privatized

4. HOW PRIVATIZATION BIDDING CONTESTS "REALLY WORK"

In an operator privatization, the basic premise is that money talks louder than most if not all other variables. The forces driving the process can be reduced to four in number:

- At the outset, there will be too many qualified bidders. At the minimum, variously four to six of the RBOCs, AT&T, Sprint, C&W, BCE, increasingly NTT, sometimes ItalCable, Telefonica (if it is a Spanish speaking country), and others all may be potential bidders.
- However, ten to twelve bidders never happens. A few stake themselves out as more serious.
- In the end there are two or three bidders. To look at the small number of final bidders is just as misleading as looking at the large number of initially interested parties. These bidders are serious and do, in fact, bid high dollar numbers.
- In all cases we have examined the final bid is far above any existing discounted cash flows. The foreign PTOs are inevitably betting on their ability to extract extra or hidden value out of the privatized domestic PTO.

5. WHAT ARE THE PRACTICAL RESULTS OF SUCH A PROCESS?

In simple terms, if a government sets up an operator privatization process based in any direct or indirect way on an auction, the winner must aggressively seek out extra value. How does the foreign operator seek to do that? There are four main ways.

First, the foreign operator will try to "fix things" so that missed revenue opportunities can be seized. For example, many developing countries with a PTO that has been or will soon be privatized can see a big jump in revenue just by installing an international gateway switch that works, plus dedicated lines to business centers. There are many other simple things that can be done in a developing country like a Venezuela or a Hungary that enhance revenue streams.

Second, the foreign operator will cut costs, generally as aggressively as is legally possible. The ability to cut staff was an issue in the privatization of Aussat, and in Venezuela, Mexico, Argentina, Puerto Rico and elsewhere. There are two forms of staff cutting that should be considered. The first is the elimination of jobs because technology, better methods and procedures and the like means the work need be done by no one. Those are true efficiencies. The second form of job elimination is the exportation of jobs out of the domestic economy to the economy of the privatizing PTO. The main areas where this is a risk are in R&D and new product development.

We make the point about job exportation by looking deeply into a case regulatory bodies should become more familiar with. In Canada, the second long distance carrier is Unitel, competing with the association of the Bell Companies, called Stentor. Unitel had made certain representations, if not promises, to the Canadian government that it would conduct R&D in Canada.

AT&T has bought a 20% interest in Unitel. CSMG has been studying this situation closely. While this appears to be a small stake, in fact operationally AT&T has taken over Unitel. Unitel has admitted that any further commitment to Canadian R&D "makes no sense" (from a CSMG interview with Unitel). Also, all future product development will come out of AT&T, with only "customization" done in Canada, if that. Such a process moves high value added jobs out of the country.

The third method for a winning privatization bidder to generate extra value out of the privatized PTO, is to work dual margins. Here we focus on Venezuela and Canada. In Venezuela, the winning bidder was the GTE consortium, with AT&T holding 5% of that consortium. (We note that the losing consortium was headed by BCE, the 53% owner of Northern Telecom.) CANTV had three primary equipment suppliers–Ericsson, NEC and Siemens. Now it has four. AT&T is already the primary equipment supplier to GTE. Even beyond raw power of ownership, AT&T and GTE have the argument that they want to better integrate U.S.-Venezuelan services, and that means AT&T equipment.

In Canada, AT&T was less subtle. Unitel on January 1, 1993 was using essentially all Northern Telecom equipment, and relatively new equipment at that. The AT&T deal was struck in January, 1993. Northern Telecom DMS equipment is already being ripped out and AT&T 5ESS and 4ESS equipment installed. The total replacement should be complete by the end of 1994.

One could argue that AT&T and BCE are the only two companies active in the privatization arena that are also major equipment manufacturers. However, there is nothing to prevent a "pure operator" from cutting a side deal with its preferred supplier to help manage its overall cost position as a way of seeking to extract extra value out of being the winner.

The fourth method will be for the privatizing winner to gain a special advantage with regard to the multinational customers (MNCs) operating in the country of the privatized PTO. Right now, AT&T, MCI, Sprint, BT, C&W, NTT/KDD, the Germans, the French, the Swedes, the Dutch and others are all scrambling to figure out what to do about providing global services to MNCs. The AT&T-Unitel deal is instructive.

Unitel's Chief Operating Officer and three direct reports are all AT&T employees, sent up to Canada shortly after the announcement of the AT&T-Unitel deal. In turn, they all came from the major business customer group at AT&T. (Thus AT&T, the 20% owner, controls or will soon control the operating management, switches, software, billing system, R&D, product development and definitions, and other key functions at Unitel, giving rise to the assessment that AT&T has "taken over" Unitel.) AT&T is using Unitel to attack directly U.S. MNCs operating in Canada as well as Canadian-based MNCs.

6. IMPLICATIONS AND ALTERNATIVES IN THE ASIA PACIFIC SETTING

Recall the overall theory of the case. First, we observe that there are at most only a few countries in Asia-Pacific–and we decline to name names–where extremely shoddy infrastructure and/or rampant corruption make the "junk the local operator operator and start again" strategy the right one. Most of Asia-Pacific is in the grey area in the middle of Figure 1, or fully in the area where a stockholder privatization is the only way to go (e.g., Japan, which has already privatized, or Singapore, where privatization is in progress as this paper is written).

In this grey area, rational policy makers must weigh the pros and cons of an operator privatization. On the one hand, the financial rewards to the government of an auction can be substantial–$1.9 billion in Venezuela for 40% of a 10 line per hundred population telephone company in a 20 million population country. On the other hand, in Asia-Pacific, there are some risks and special circumstances:

- Auctions will create all of the pressures described above for the new operator to take unusually aggressive actions.

- Operator privatization bidders have, to date, overwhelmingly been dominated by North American and European bidders. Business and cultural practices vary far more widely between Asia and those two continents, than do practices in most of the already privatized countries (e.g., New Zealand, Mexico, Venezuela). If the privatizing operator comes in with a "slash and burn" mentality, the risk of causing major–indeed in the end inefficient–disruptions is greater.

- Asian PTTs–notably Taiwan and Singapore–have shown that rigorous internal benchmarking and focused effort alone can produce remarkable results over time.

Against this backdrop, there are alternatives. One of the most attractive is to pursue a policy of using a Build-Operate-Transfer (BOT) for a part of the country. Such an activity can both address the toughest local problem, as well as set a standard for the other regions of the country to follow (including providing a living laboratory of how to do it). Of course, a BOT may solve the capital infusion problem for one part of a country while the rest goes begging.

A second alternative is a management contract with incentives for superior performance. Sharing rewards-and at least some risks-can make for more rational resource allocation overall.

Third, competition can be introduced on an accelerated basis. This is what has happened in Australia, with positive effects on the customer oriented performance of AOTC-Telstra.

A fourth method we do not advocate is pure reliance on paid-by-the-hour rather than paid-for-results consultants. Consulting should be part of any solution, but the intense challenges of implementation need greater economic drivers than pure advice givers can provide.

The conclusion of all of the above is not that operator privatizations are bad or generally inappropriate. Instead, this paper is an entreaty to policy makers to consider three simple things:

- Operator privatizations may, sometimes, be at odds with developing the best possible telecom sector for a country.
- The risk of the above may be higher in Asia-Pacific.
- There are alternatives worth considering.

Privatization: Framing Performance Requirements
Within Macroeconomic Polices and Strategies

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1. Abstract

This paper analyzes privatization of telecommunication systems in Mexico, Chile, Argentina, and Venezuela by describing the telecommunication and privatization legislation leading to privatization, and the concession agreements and performance requirements, as they are embedded within the context of macroeconomic planning in these countries. Issues raised by the Maitland report are addressed as they relate to concession agreements, FDI, and effective technology transfer.

2. INTRODUCTION

This paper analyzes privatization of telecommunication systems in Mexico, Chile, Argentina and Venezuela by comparing their choices of performance requirements and how these requirements fit within the context of their macroeconomic policies and strategies. Implications for trade with the Pacific Region countries are discussed, linked to each country's macroeconomic policies and planned infrastructure. Issues raised by the Maitland Report are addressed as they relate to performance requirements, FDI (Foreign Direct Investment), and effective technology transfer.

All four countries developed macroeconomic policies in response to national and international pressures for fiscal and economic restructuring. Each of the four countries realized the need for stabilization of its economy, and for political stability and each understood that efficient operation of the telecommunication infrastructure was crucial to increasing international trade, attracting FDI, and the expansion of domestic enterprises.

Even though their goals were similar, their economic policies, strategies, and approaches to successful technology transfer differed. Since the privatization process is framed by macroeconomic policies and strategies, performance requirements differed.

Technology transfer is based on the development of human resources, implying the need for successfully identifying participants capable of affecting the outcome, and including them in the telecommunication process. Mexico is putting a fiber optic cable infrastructure in the National University of Mexico because it has identified the university as the key to the development of human capital. The other countries have not. While all four countries strive to stabilize their economies and to achieve political stability, their macroeconomic policies and strategies are different. This is reflected in performance requirements, an ultimately in trade patterns with Pacific Region countries.

3. ARGENTINA

3.1 HISTORICAL BACKGROUND, MACROECONOMIC GOALS, POLICIES AND STRATEGIES

Argentina held the world record for inflation for almost a decade and a half, from 1975 to 1989 when the annual rate of consumer price increases was 4923.6%, before reducing it dramatically to 26.97% in 1992. Against this backdrop privatization began. Several economic plans were tried over the decade, and the fate of the latest, emphasizing stability, reactivation and growth, seems to hinge on the success of the Convertibility Program implemented in April 1991 in the battle for monetary stability.

The government reports a recovery of fiscal and monetary solvency. For the first time in decades, the public sector will show a consolidated surplus after interest payments (excluding capital resources). The tax system has been simplified, with the introduction of a value added tax (VAT) from 18% to 27%, import duties reduced to an average tariff of 10% plus a 3% statistical tax (temporarily raised to 10%). Capital flight was intense in the eighties, but the capital is beginning to return.

The government is stressing investment and exports as its main engines of growth. According to government figures, inflation is trending towards international norms, economic recovery is occurring, and structural reform is being achieved with a sustained increase in the level of employment. The dramatic fall in inflation coupled with economic recovery and stability have produced substantial reductions in the number of indigent and of households below the poverty line. From 1988 to 1992, household poverty level decreased from 25.7% to 15.6% and indigence from 6.4% to 2.4%. (The survey was based on reported income, believed to be underestimated by about 20%, so the percentages have been inflated to reflect estimated unreported income. MINISTERIO DE ECONOMIA Y OTRAS Y SERVICIOS PUBLICOS REPORT)

The economic plan has emphasized reform of the State, including privatization of almost all state-owned companies, easing of restrictions on foreign trade and investment and the development of free markets. Within this context the government telephone monopoly, ENTEL was privatized.

3.2 TELECOMMUNICATION INFRASSTRUCTURE AND PRIVATIZATION

Prior to November 1990, ENTEL, the state-owned and operated telecommunications company provided all telephone services. In August 1989, the State Reform Law was passed, which specified privatization procedures and divided the telecommunications network into two equal regions, Northern and Southern, of approximately 1.5 million lines each. In November 1990, Telefonica de Argentina, a subsidiary of the Spanish State-owned Telefonica de Espana was awarded the Southern area (including 57% of Buenos Aires) and in November 1991 the consortium Telecom Argentina, led by STET (Italy) and France Telecom obtained the Northern area (including 43% of Buenos Aires). Telefonica de Espana took charge of operations for Telefonica while Telecom entered into a management contract with STET and France Cables. Telephone density stood at 10.9 lines per hundred inhabitants. *The environment of the Telefonica region was and is* one of low-development with high growth potential.

The 1989 law also created two new companies, Startel and Telintar, and divided the equity ownership equally between Telefonica and Telecom. Each new company was awarded licenses to provide other telecommunications services. Telefonica's and Telecom's exclusive licenses run through 1997, and may be extended through 2000 if they meet government-mandated targets for expansion, modernization of the network, and rate restructuring.

A large increase in the price of the telephone pulse followed the privatization brought about a strong negative reaction from users. Cellular telephony increased by almost 100 percent, due to the price increase and the poor quality of the telecommunications systems. The average utilization per subscriber was about 400 minutes per month, much higher than the U.S. and European norm of 150 minutes per month.

In March 1992, public telephones were almost unavailable in Buenos Aires during prime time for banking and financial transactions, noon to 6:00 p.m. Calls were limited to a bare minimum because the demand far greater than the switching connection capacity available. By the end of 1992, reports for Telecom still showed a density of 10.2 with 12.6 for Telefonica, but it was far easier to make a telephone call in some other Latin American capitals with a much lower density during financial transaction hours.

3.3 CONCESSION AGREEMENT AND PERFORMANCE REQUIREMENTS

In the Northern Region, the Telecom network began with a smaller base of access lines, therefore target compliance requires a higher annual growth rate of new lines. To maintain its ten-year franchise, 752,000 new lines need to be added by 1997. The company has budgeted $3.3 billion, planning to add 2.1 million new lines by 1997. (Its budget and estimated cost per line installation are 24% less than Telefonica's projections).

Telecom needed to achieve a 7.3% compounded annual growth. By September 1992, a yearly gain of 18% had been achieved helped by a 62% increase resulting from its 1992 purchase of CAT, an LM Ericsson subsidiary, the only other operator providing basic service in the region. Telecom is also strongly committed to introducing a higher percentage of digital exchanges.

In the Southern Region, Telefonica has also met its goals. A 12.7% increase in lines was achieved in 1991-1992. The company is aiming for a compounded annual growth through 1996, of 12.2%, far exceeding the government's target of 5.3% to 6.7%. Network digitalization had increased by 6% over the year to 24.% with projections of 60% by 1996. If these goals are met, lines per 100 inhabitants will increase to 18. Line repair times were reduced from 16.4 days in 1990 to 1.67 days in 1992, and between 1990 and 1991 the waiting time for a new line was reduced from 4 years to 14 months. In November 1991, both Telefonica and Telecom signed an agreement with the Argentine government calling for rates to be denominated in U.S. dollars and to be adjusted semi-annually in accordance with the U.S. Consumer Price Index. In 1992, both companies billed their customers in local currency using the $US exchange rate prevailing at the time of billing. If the exchange rate remains fixed, and Argentine inflation exceeds that of the U.S., the financial returns for both companies could be adversely affected, reducing their ability to expand and upgrade the networks.

Argentina, a beautiful country of magnificent resources had reached a crucible by the eighties, brutal dictatorship, squandered resources, and loss of belief in itself. Privatization of ENTEL was one part of the overall attempt to bring back fiscal, political, and social stability to a system nearing chaos.

4. CHILE

4.1 HISTORICAL BACKGROUND

On March 9, 1983, The Financial Times quoted a diplomat in Santiago as saying, "Mexico and Venezuela had oil, Argentina had wheat -- Chile had confidence and the bankers liked that particular product at the time". Between 1973 and 1981 the annual inflation rate dropped from 1000% to 10% while the GNP grew by 8 or 9% annually, managed by the "Chicago boys". Average tariffs on imports were slashed from 105% in 1973 to 10% in 1979, and the balance of payments was strong and reserves growing. A few years later, economic disaster struck. In 1982 the GDP fell by 14.1%, perhaps not matched by any country since the 1930s. The external debt of $17 billion, on a per capita comparison, was more than double that of Brazil, and 30% higher than of Mexico. Official unemployment was around 20% with an additional 15% of the labour force kept on Government make-work programmes at minimal wages.

Now, another decade later, Chile is a democratic country, with the Pinochet years an aberration in its long democratic tradition. "Civilian rule hasn't hurt Chile in attracting Capital" according to the Los Angeles Times in 1992. The article described a civilian government with socialist leanings proving that it can attract private foreign investment just as well as the Junta. Chile is now the Latin American country that attracts the most foreign investment in proportion to its economy. What happened?

4.2 MACROECONOMIC GOALS, POLICIES AND STRATEGIES

A program of economic reforms was developed, the main emphasis of which was to open the Chilean economy to world trade and competition. Foreign trade and investment within a framework of macroeconomic stability became the cornerstones of economic and social development. In 1991, the GATT report on Chile stated that Chile had experienced a highly volatile economic performance over the past 30 years . . . Only after the government initiated a new structural adjustment program in the period 1985-88, was sustained recovery possible . . . Building on these reforms, the present policy approach remains strongly market oriented. Chile's trade links with the world economy have been further broadened through the ongoing process of export diversification . . The Chilean experience suggests that rapid trade reforms, when combined with an appropriate mix and sequencing of stabilization policies, are a sustainable recipe for improving economic performance

4.3 THE CHILEAN GOVERNMENT COMMENTED ON THE REPORT.

Chile's objective is to strengthen the linkage between the Chilean economy and the major international economic flows on the basis of competition . . . bilateral treaties are seen as a means of complementing international agreements (Bureau of National Affairs, Inc. International Trade Reporter, July 17,1991)

4.4 BECOMING AN EXPORT PLATFORM THROUGH TRADE AND INVESTMENT WAS THE GOAL.

The breezes of privatization blew across the country -- in an orderly fashion. Chile had embarked upon an extensive privatization program, beginning in 1974 with 541 of its 596 state owned enterprises privatized before the end of the decade. The crisis in 1982-93 saw dozens of firms reverting, once again, to the state. These included several commercial banks, the largest association of pension funds (AFP), and large commercial firms. Before the second round of privatizations began, the government studied its previous record and was ready to the same mistakes. Their analysis revealed that "method" was key to successful implementation of the privatization decision. In the second round of privatizations, process was important. A fundamental distinction was made between the decision to privatize and the methods used to implement the decision. This changed the process because the question "what to privatize" was responded to separately from the questions, "how and when" to do it.

The government set clear objectives for its privatization program. They were:

a) to improve the long-term efficiency of the economy;

b) to disperse ownership by selling shares to the public, employees or pension funds; to reinforce the role and scope of pension funds; to provide the central government with the revenues to implement social programs to support the needy members of society.

To disperse ownership several methods were used: popular capitalism, workers capitalism (the government developed several mechanisms to facilitated share acquisition by employees); institutional investors (e.g. pension funds, it should be noted that out of $20 billion market capitalization, about 40% corresponds to pension fund shares); the stock market; and national and international open bids. Privatization of the CTC and ENTEL used a combination of these methods. Prior to privatization, substantial reforms were introduced into the management and operations of state owned enterprises until they were efficient enough to compete with private Chilean and foreign firms.

The social sector did not suffer with privatization. President Aylwin was able to revamp public sector efforts in investments and social programs at the same time curbing inflation by maintaining a fiscal surplus and a high level of saving. In the last National Socioeconomic Characterization Study, November 1992, the number of destitute poor had been cut by 43% since 1987. Unemployment stands at 4.5%, inflation runs at 12.5% and levels of investment surpass the 20% mark. The IMF reported that Chile's growth of 10.4% GDP in 1992 was top in the western hemisphere and third in the world behind China. The government has concentrated on achieving economic growth with stability.

4.5 THE PRIVATIZATION PROCESS AND TELECOMMUNICATIONS INFRASTRUCTURE

It is within the overall context of Chile's drive to become an export platform while maintaining its educational and social goals, that privatization of CTC and ENTEL are to be understood. Telecommunications had been one of the most dynamic sectors in the country since the first round of privatization in the late 1970s (CTC had previously been privately owned by ITT, underwent change to government management control by intervention in 1971, and the sale of ITT shares, 80% of total shares to the Corporation for the Promotion of Production (CORFO). Chile was the first country in Latin America to abolish the state monopoly on telecommunications services and to facilitate the privatization that began in 1978 with the National Telecommunications Policies Act. This allowed the government to grant concessions, licenses and permits for the provision of services, and was followed, two years later by the General Regulations of Telephone Services allowing free transfer of telecommunications lines. By 1981, the state monopoly over telegraph and telex services had been completely eliminated. The 1982 General Law of Telecommunications provides the basis for competition in all telecommunications services. Between 1982 and 1988, the government completed the sale of its majority interest in all state-owned telecommunications companies, including CTC, ENTEL, both totally privately held today. Telefonica de Espana holds a substantial stake in both companies. It acquired 50.2% of the shares in CTC from the Bond Corporation that had previously obtained its shares in a direct sale in January of 1988. It has held 20% of ENTEL since 1989 with Chase Manhattan Bank holding about 10%. Pension funds, employees, and smaller investors also own shares in both ENTEL and CTC.

4.6 CONCESSION AGREEMENT AND PERFORMANCE REQUIREMENTS

Concessions emerge from and are regulated by the Telecommunications Law 18.168 of 1982. This reformed the telecommunication sector by liberalizing the market. Previously, Law DFL4 of 1959, had a number of dispositions that discouraged market competition. Under the new law, conditions that the concession holder must fulfill are specified for the installation and operation of the specific service. Concessions may be for a fixed period or may extend indefinitely, and apply to a specific geographic area. After a certain time the concession holder is obligated to provide services of appropriate quality to all parties requesting the service, after which the geographic area becomes the "compulsory service area". CTC has until 1997 to integrate the various localities within its geographic concession areas into its local telephone system. To comply with the terms, CTC has published a calendar which sets forth the schedule for such integration on a year-by-year basis.

Once the respective date for a locality's integration occurs, that locality becomes part of CTC's compulsory service area and CTC is obligated to provide services to all applicants for service in that locality within the succeeding three years. Under the concession, CTC must effect such interconnections with holders of other concessions as are required to ensure the availability of public service to all users and the continuity and compatibility of the country's network. If non-compliance occurs, notice is given and the concession can be terminated by executive decree of the Ministry of Transport and Telecommunications if CTC is in contravention of the law or does not comply with the terms and conditions to which is subject. If termination were to occur, CTC could appeal to the Chilean courts. The 1982 concession document is 105 pages long, but only two pages contain articles of the decree and they are general, i.e., CTC is obligated to maintain modern efficient service with objectives based on current norms and those dictated in the future by the Sub secretary of Telecommunications. There is one specific item in the two pages. The concession has a duration of 50 years. The other 103 pages describe the geographic areas covered, the type of transmission equipment installed and service.

While CTC and ENTEL are the major telephone companies, there are others and it appears that four companies will be permitted to offer long distance services.

Since the privatization of CTC in 1988, telephone density has increased from 5 per hundred inhabitants to 10; the number of lines in service has more than doubled; digitalization has increased from about 38% to 76% with plans for total digitization this year, and 10,094 km. of fiber optic cable have been installed. Future plans include completely satisfying demand for basic service by 1997, implementing ISDN applications, and putting into operation a totally digital network of fiber optic cable linked to satellites.

Chile's peculiar geography represents an incentive for the use of telecommunication technology as a way to increase productivity, reduce costs, program stocks and deliveries, and implement better quality control. Chile attends trade fairs all over the world and is heavily involved in building trade with the Pacific Region. It even exports chopsticks to Japan. In its push for economic progress through trade and export, the need for telecommunication infrastructure was well understood.

5. MEXICO

5.1 HISTORICAL BACKGROUND

The success of Mexico's economic strategy since 1988 has led to its gradually regaining access to international capital market financing after having been virtually excluded for almost a decade. This private sector access to capital, in combination with Mexico s strong macroeconomic policies, has positioned the country as one of the most stable economies of the world today and a leader in Latin America's economic restructuring.

Prior to the 1982 debt crisis, Mexico had adopted a strategy of "stabilizing development" based on rigid inward-looking policies. The strategy was highly successful in the beginning but not sustainable as it was framed by high protective barriers, focusing on import-substitution and rapid expansion of the domestic market. Correspondingly, economic inefficiencies became prevalent, with industrial growth mostly a result of capacity expansion with little productivity gains.

Mexico's growth had been based almost exclusively on crude oil export earnings and on foreign borrowing. Therefore, it was no surprise that in the early 1980s, after the first signals of a weakening oil market and with foreign interest rates at unprecedented levels, the Mexican economy gradually drifted into troubled waters. Severe and unanticipated pressures elevated the external debt, caused inflation to spiral upward and precipitated crisis level declines in gross domestic investment, productivity, employment and the general standard of living. The latter was attributed to inefficient productive structures resulting from protectionist policies, counterproductive government participation in economic activity and barriers to foreign investments.

5.2 MACROECONOMIC GOALS, POLICIES AND STRATEGIES

The Government of Mexico has tackled the 1982 debt crisis with a rigorous stabilization which has been consolidated under President Carlos Salinas de Gortari's administration. This program can be best described by outlining three fundamental objectives:

1) Stabilization of the economy as a means of improving the quality of life and strengthening the economic base,

2) Globalization and opening of the economy as a means to stimulate market development and competition,

3) Privatization and deregulation as a means to foster an economic environment conducive to capital investment, modernization and growth.

The strategies that have been followed in order to achieve these objectives can be summarized as follows:

a) Re-negotiation of foreign debt which has moved a former level of consolidated net debt equal to almost 70% of the national product in 1988, to one of only 26% in 1992. Consequently, for the fifth consecutive year, inflation has been reduced from almost 200% in 1987 to a level that has already reached 10% in 1993 and continues to fall.

b) Fiscal discipline, which has included fiscal reform, government spending cuts and downsizing. The budget deficit has thus disappeared for a second consecutive year, aiming for a surplus of almost 2% in by the end of 1993.

c) New legislation on foreign investment which has set tariff levels at a maximum of 20% has managed to dramatically increase FDI. This has attracted capital that has helped to broaden and diversify Mexico's export platform increasing non-oil exports from 20% of total exports in 1982 to 75% in 1992.

5.3 TELECOMMUNICATIONS INFRASTRUCTURE

A telecommunications revolution is underway in Mexico that is aimed at transforming Mexico's telecommunication network into the largest, most comprehensive and modern in Latin America. Mexico's 8 billion dollar market for telecommunications equipment and services is a testament to the level of economic activity taking place.

In the early 1980s, Telmex described its own situation as one of "poor delivery, reliability and service quality. The average waiting time for a telephone line was three years. By 1989, it was obvious that a modern telecommunications infrastructure was a necessity if Mexico was to develop as well as attract investment.

One of the most important objectives in Mexico's overall macroeconomic policy has been that of privatization and deregulation where the telecommunications sector has been a crucial target. This policy acknowledges the fact that domestic economic stability and the stimulation of trade can be sustained only if they exist in the context of growth driven by private sector capital and initiatives. In fact, the development of a world-class telecommunications system was given a high priority in President Carlos Salinas de Gortari's 1989-1994 National Development Plan.

Following this mandate, the Government undertook in 1989 and 1990 major steps to reform and modernize this vital sector, among which are the following

- The Secretariat of Communications (SCT) withdrew from the direct provision of telecommunications equipment and services by decentralizing its activities into a company called Telecom Telecom was created as a semi-autonomous government entity, overseen by SCT, to supply satellite and telegraph services which are reserved constitutionally to the State
- Telmex, the national telephone company was privatized The Government opened the market to new telecommunications service providers This was highlighted by the creation of nine different cellular phone regions each of which was awarded a concession to compete with the cellular affiliate of Telmex
- Foreign corporations were authorized to invest up to 49% in Mexican telecommunications companies
- Changes in the country's telecommunications tariff and tax policies were instituted to better reflect both real costs and international prices

Currently, Mexico has around 6.5 million lines installed This is a line penetration of 7.8 per 100 inhabitants The network is heavily concentrated in the Mexico City metropolitan area which accounts for 29 percent of all lines installed If line growth continues to expand at the present rate of 13% per year then Mexico should reach a line density of 11 lines per 100 inhabitants by 1995, which is still low compared to other developed nations which typically have at least 20 lines per 100 inhabitants Presently under construction is a 13,500 kilometer fiber optic network which is expected to be completed by the end of this year and which will serve as the backbone of Mexico's long distance network Telmex also offers fiber optic services to its major customers which is done primarily through its Red Digital Integrada (RDI). This is a fiber optic system superimposed on the normal network for high speed data transmissions for use by private companies and the National University

5.4 CONCESSION AGREEMENT AND PERFORMANCE REQUIREMENTS

Telmex was privatized in December 1990 and it is now controlled by a consortium composed of Grupo Carso which holds 10% of the voting shares and Southwestern Bell and France Telecom which own five percent each Southwestern Bell has also purchased another batch of non-voting shares representing another five percent of the equity

Telmex's role in the development of Mexico's telecommunications infrastructure can be understood by looking at the 1990 Concession, published in the Diario Oficial on December 10, 1990, which defines Telmex's operating areas and sets clear service targets The Concession allows Telmex a near-monopoly for six years After 1996, the government reserves the right to assign new concessions to other telecommunication operators The Concession dictates that Telmex must meet specific service targets that include the following

a) Showing line increases of 12% each year between 1990 and 1994 (line growth for 1992 was around 13.8% exceeding the target).

b) Providing automatic switch service to all towns with more than 5,000 persons by 1994.

c) Cutting phone installation delays to 1 month by the year 2000,

d) Offering unrestricted capacity for other telecommunication companies

e) Improving the overall quality of services.

f) Providing basic telephone services to all towns of 500 persons by 1994

To meet the service targets specified in The Concession, as well as expand and modernize its infrastructure, Telmex's owners have embarked on a huge capital investment program The company s first three year plan, 1991-1993, was intended to increase its total infrastructure by 63% and improve service aiming to increase the number of telephone lines to 7.5 million, double the number of public pay telephone by installing 96,000 digital telephones and 7,500 traditional telephones, replace 470,000 traditional telephone lines with digital telephone lines, and quadruple access to the integrated digital network. Since its privatization, Telmex has for the most part been successful in meeting, and sometimes even exceeding the conditions of its concession

6 VENEZUELA

6.1 HISTORICAL BACKGROUND

During the 1970s, Venezuela enjoyed growth in democracy, education, and distribution of wealth that stimulated expectations and rising hopes for much of a population Then came the eighties Economic pain brought political instability and demoralization as high level corruption and mismanagement in the government came to light. The macroeconomic plan and implementation plan emerged from the economic, social, and political upheaval of the eighties Budgets had been based Venezuela's petroleum, but revenues from oil production dropped more than 75% between 1981 and 1993 By 1989, it was apparent that major adjustments were needed in fiscal plans

In 1988, there were multiple exchange rates with the top rate 300% above the lowest, controls on interest rates and prices, multiple barriers in place to FDI, and a distorted tariff structure The government indiscriminately subsidized some sectors and maintained inefficient state-owned enterprises It repressed inflation, stocks were taken off the stock market, interest rates were kept artificially low in the financial markets, and the currency was greatly devalued

Results were predictable The foreign sector suffered Reserves shrank to 1.8 months, there were multiple deficits along with mismanagement and corruption in exchange rates, and payments were due on foreign loans without possibility of refinancing Capital flight was endemic and Venezuela faced exclusion from the international financial markets

6.2 MACROECONOMIC GOALS, POLICIES AND STRATEGIES

The government agenda for 1989 prioritized adjustments necessary for correction of macroeconomic imbalances Strategies to correct the imbalances included, unifying the exchange rate; freeing prices and interest rates; reducing public spending by cutting indiscriminate subsidization and transferences to state-owned organizations; and renegotiating the external debt. Structural reform was to be the basis of a new model for growth permitting economic reforms, social reforms, and institutional-political reforms.

Moving from a closed, protected economy to an open, competitive one required legislative measures to reduce barriers to Foreign Direct Investment (FDI), clean up some of the public financial institutions, and move towards privatization.

Compania Nacional de Telefonos de Venezuela (CANTV) was one of the first targets. Firms daily protested the lack of telecommunication infrastructure, private individuals complained to the newspapers, and it was clear the government could not afford to improve the system. A short deadline was given, and interested firms submitted their bids for the concession.

6.3 TELECOMMUNICATIONS INFRASTRUCTURE

Until 1991, the Compania Nacional de Telefonos de Venezuela (CANTV) was publicly owned. The woefully inadequate telecommunication infrastructure led to people waiting years in lines, and in many cases up to two years for repairs. There were too few public telephones and these were generally broken. Larger MNEs developed their own systems using combinations of private line and microwave facilities. So many extra-official lines were installed that a nameless telecommunications consultant in Caracas commented that when the installer died nobody would know where the lines were buried. Revenues for long-distance calls were transferred for uses other than building or maintaining needed telecommunication infrastructure. The relationship between CANTV and the public tended to be adversarial rather than that of a provider attuned to a customer's needs.

The government, recognizing the need for modernization and expansion of the telecommunications infrastructure, privatized CANTV in 1991. Other factors influencing the decision were a lack of capital for investment, a need for FDI, and CANTV's lack of management and operational expertise.

CANTV was privatized in 1991 with 49% government ownership, Employee Trust 11%, and a consortium (operator) of 40%. The consortium is led by GTE (51%) and comprises Telefonica Internacional de Espana (16%), La Electricidad de Caracas (16%), Consorcio Inversionista Mercantil-CIMA (12%) and AT&T (5%). With 20,000 employees, a base of 1,600,000 clients, 700 telephone exchanges, 300 commercial offices and direct international calls with 100 countries, CANTV is the largest private company in Venezuela. It has an exclusive concession on the basic network until 2000.

According to the ITU, in 1990, there were 1,468,169 access lines, 7.4 lines per 100 inhabitants, 100,000 people on the waiting list for a principal line with an average wait of 234 months or about 19 1/2 years, 31,300 public phones or 1.6 phones per 1000 inhabitants, and about 51 lines per employee. CANTV expenses exceeded revenues by $87,000,000. Public telephone statistics per inhabitant are almost meaningless.

When privatized CANTV took control in Dec. of 1991, 57% of pay phones were out of order, along with 10,000 out-of-order trunks. There was a 30% international call completion rate and a cellular capacity in Caracas of 10,000. According to CANTV, these figures in April, 1992 had improved to 30% out-of-order pay phones, 3,500 out-of-order trunks, 36% rate of completed international calls and cellular capacity of 20,000 in Caracas. Later figures show telephone penetration is 9.1 per 100 inhabitants, 85 lines per employee, a drop to 20% international call completion, and 20% of the lines are digital.

6.4 CANTV CONCESSION AGREEMENT AND PERFORMANCE REQUIREMENTS

The concessionary term of 35 years with renewal of 20 years covers all telecommunication services, including voice, data, video, and news services. There is exclusivity granted for 9 years for provision of switched service. There are specific mandates with target dates of 1992, 1996, and 2000. The year 2000 includes the following mandates to have been met: 4 million lines in service, 80% digital, call completion rates (local 68%, national 68%, international 65%); out of service (reports 2.5 per 100 lines, 70% repair in 24 hours., 96% repair commitment met); installation interval, 98% in 5 days; pay stations - 10,000; 85,000 pay stations in service. Price cap regulation allows controlled rate rebalancing to reduce rate cross-subsidies. Rate increases are indexed to inflation.

The concession can be terminated with reasonable penalties specified for non-compliance. CANTV's business plan focuses on improving reliability and availability of network service, improving customer focus (with emphasis on satisfying large customers), satisfying concession mandates, satisfying objectives set by market and mandates through organizational adjustment and network overhaul, and ultimately to achieve appropriate financial returns through providing quality, efficiency, and expansion.

7. CONCLUDING REMARKS

While the Maitland Report suggests that "equipment for use in advanced countries may suit conditions in developing countries", it could be argued that fiber optic networks are the exception. They allow for "leap frog" modernization to take place and are far easier to maintain. These countries are making efforts in varying degrees to implement fiber optic networks.

All four countries faced similar problems of different magnitudes during the eighties, therefore decisions to privatize their telecommunication systems were more painful for some than for others. It is too early to evaluate the impact of privatization on social progress, FDI, exports, or integration into the global trading system that these countries see as their goals. However, some of these countries have more closely tied telecommunication infrastructure to these goals than others. Chile learned from its mistakes in its first round of privatizations and envisioned privatization as an integral part of its macroeconomic planning, with the telecommunication system as the key to success for its social, political and economic stability through internationalization of trade. Its history of democracy and emphasis on building a meritocracy contributed to the success it is presently enjoying.

Mexico is also developing a vision of its future permitting it to engage in long-term planning with telecommunications and human capital as keys to its success. Stretching a fiber optic spine along country that includes the University of Mexico will help ensure the development of capable future leaders.

Argentina and Venezuela are setting goals for implementing certain performance requirements, but it is not clear how integrated the privatization or technology transfer is into their long-term plans. Perhaps it is fair to say that Argentina is too newly emerged from crisis, and Venezuela is still struggling to emerge, so that their long-term plans have not been clearly enunciated.

TABLE 1. TELECOMMUNICATIONS PRIVATIZATION PROCESSES

YEAR	ARGENTINA	CHILE	MEXICO	VENEZUELA
1978		National Telecommunications Policy Act		
1979				
1980		General Regulations of Telephone Services		
1981				
1982		General Law of Telecommunications		
1983				
1984				
1985				
1986		Government had completed sale of its majority interest in all state-owned telecommunications companies		
1987				
1988				
1989	State Reform Law	100% private ownership of *CTC* and *ENTEL*	*Secretariat of Communications (SCT)* decentralized activities into *Telecom*, a semi-autonomous government entity, nine cellular regions created to compete with cellular affiliate of *Telmex*	
1990	*Telefonica* awarded Southern Area and 57% of Buenos Aires *Telecom* awarded Northern Area and 43% of Buenos Aires		Foreign corporations authorized to invest up to 49% *Telmex* privatized, Dec 1990 Government 51% Private Ownership 49%	
1991	90% privatized with government retaining Class C shares, 10%			*CANTV* privatized Government 51% Private Ownership 49% (Employee Trust 11%, Consortium 40%)
1992				
1993				

TABLE 2 CONCESSION AGREEMENTS AND PERFORMANCE REQUIREMENTS

	ARGENTINA	CHILE	MEXICO	VENEZUELA
1988		CTC Fifty year concession depends on mandates for 1997 and 2000 being met		
1989				
1990	Ten year franchise if mandated targets met by 1997; Rates denominated in US. dollars adjusted semiannually to US. Consumer Price Index; clients billed in local currency using $US. prevailing exchange rates		Near monopoly for six years with government reserving right to assign new concessions to other operators depending on 1994 requirements met	
1991				Concession has 35 year term with renewal of 20 years if mandated targets for 1992, 1996 and 2000 met; covers all telecommunications services including voice, data, video, and new services, 9 year exclusivity for provision of switched service, rate increases indexed to inflation
1992				1.7million lines in service, 25% digital; call completion: local 52%, national 38%, international 25%; out of service repairs: 52% in 24 hours, 70% repair commitment met; pay-stations 45,000 in service
1993				
1994			Line increases of 12% per year; automatic switch service to all towns with population of more than 5000,; phone installations within one month of petition, basic services to all towns of 500 persons	
1995				local 63%, national 80%, international 57%; Out of service repairs: 64% in 24 hours, 85% repair commitment met; installation interval 80% in 90 days, pay-stations in service 65,000.
1997	Targets to be completed: network expansion, modernization , and restructuring. Telecom - 7.3% compounded annual growth Telefonica - 5.3-6.7% compounded annual growth	Various localities to be fully integrated into geographic concession area and converted to compulsory service areas		
1998				
1999				
2000	Concession ends	Services provided to all applicants in concession area		4 million lines in service, 80% digital; call completion: local 68%, national 68%, international 65%; out of service repairs: 70% in 24 hours, 96% repair commitment met; installation interval 98% in 5 days; pay-stations in service 85,000 Concession ends - Renewal for 20 years
2026				
2038		Concession ends		
2046				

The Privatisation and Regulation of Singapore Telecom

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ABSTRACT

The privatisation of Singapore Telecom has been one of the most followed processes since trends toward telecommunication privatisation, market liberalisation and deregulation have begun to take effect to varying degrees in parts of Southeast Asia. This paper discusses the history and process of telecommunication privatisation in Singapore leading to its first public share offering in late October 1993. Some regulatory restructuring has also been a part of the privatisation process leading to a tariffing policy which is only vaguely defined. Singapore's rather unique approach to regulation and pricing is discussed along with implications of the Singapore model for developing countries.

1. Introduction

Singapore Telecom, the government owned monopoly telecommunications operator has been highly successful. With a telephone density of 47 sets per 100 population and more than one million telephone lines for a population of 2.8 million people, Singapore has one of the world's most modern telephone systems and sophisticated telecommunications networks. Singapore Telecom's figures, for the year ended March 31, 1993, show a group net surplus (after tax profit) of just over S$1 billion (US$600 million). This is a 13% increase over the previous year on revenues of S$2.76 billion, also up 11 percent. In the previous two years, Telecom had also reported a large net surplus of S$892 million in 1991, and just over S$1 billion as well in 1992. The company has only approximately S$50 million of long-term debt. Singapore Telecom is also in middle of a five year period (1990-1995) which will see new investments in systems and services totaling more than S$2 billion. This investment will culminate, among other projects, in the completion of the fibre-optic network "to the curb" by 1996.

Singapore Telecom has also been expanding beyond the borders of this tiny island nation with foreign investments through its subsidiary Singapore Telecommunications International. STI is actively forming alliances as well as providing services and expertise to telecommunications entities in other countries including service agreements with such diverse countries as Sri Lanka, Mauritius and Saudi Arabia. STI's venture investments include, among others, a 9% stake in Shinawatra Datacom of Thailand and a 27% stake in Globe Telecom of the Philippines, the latter for the purpose of developing nation-wide cellular telephone services and an international gateway. STI is also diversifying its holdings, owning an interest in a U.K. cable television company as well as owning a private television broadcast station in Sri Lanka. STI is also developing interests in Vietnam, Cambodia and China along with having established itself as a multinational corporation in Brunei and Indonesia.

Perhaps the most significant factor which makes Singapore Telecom stand out in comparison to other state-owned and operated telecommunications entities, has been its ability to keep abreast of technological developments and provide near complete telecommunications services. Where economies of scope for the public sector telecommunication authority are being constantly reduced by the development of innovative technology in the private sector, Singapore Telecom has been in a position to simply purchase and incorporate the new technology into its systems. The erosion of the economies of scale which may compel a shift from a natural monopoly to more liberalised policies in other countries is simply not taking place in Singapore. Due to the Republic's relatively small size and single urban nature, Singapore Telecom, as a monopoly operator, has been able to develop comprehensive telecommunications systems without the burden of rural or multiple urban areas as in other countries.

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Nonetheless, other factors have begun to shape a structural shift in Singapore. With reciprocity in telecommunications trade at issue in international trade agreements including the GATT, Singapore has been concerned that holding its position vis-a-vis other countries will be more difficult if it does not begin to open its own telecommunication markets and services. With STI's expanding interests into markets abroad, Singapore will be under increasing pressure to reciprocate at home. Primarily, only the CPE market and aspects of value-added networks have been liberalized in Singapore with Telecom holding a monopoly over nearly all systems and services. The majority of foreign interest in Singapore telecommunications has been through various alliance schemes and sale of equipment.

2. STRUCTURAL CHANGE OF SINGAPORE TELECOM

The major changes in Singapore have been the corporate reorganisation of Telecom and the privatisation plans. In 1989, Singapore Telecom underwent a restructuring in order to orient the company toward the customer. Strategic Business Units, namely business communications, residential communications and mobile communications among others, were set-up to accomplish this goal. In addition to the introduction of the SBUs, the new structure was intended to bring about a shift in responsibility and authority, giving the units greater accountability. The move permitted senior management to focus their efforts more toward policy decisions and strategic planning. Other aims included the integration of functions in order to create a labour force with a wide variety of skills and for the purpose of fast exploitation of technological opportunities along with an improved utilisation of resources.

In anticipation of increased market liberalisation and competition in the CPE market as well as more open bidding for equipment provision to the operator, Telecom spun off a wholly-owned subsidiary, Telecom Equipment. It was also at this time that STI was created.

More often than not, the reasons for these structural changes are officially cited as the need to change the cumbersome nature of internal procedures of a Statutory Board of the government toward a more efficient corporate organisation. These changes have placed the organisation in a good position to be formally corporatised and eventually privatized.

3. THE PRIVATISATION PROCESS

In 1985, the Government of Singapore began discussions on the possible privatisation of public sector holdings. In 1987, the Public Sector Divestment Committee Report recommended that selected statutory boards be privatised. By the end of 1989, when the corporate reorganisation of Singapore Telecom was well in progress, the Government announced that the Telecommunication Authority of Singapore (TAS), the Statutory Board which included Singapore Telecom, would be the first such Board to be privatised and shares to be floated in the market. No date was set publicly at that time however.

Singapore Telecom initially invited nine companies to submit proposals for the privatisation scheme. Morgan Grenfell (Asia) Ltd along with Touche Ross Management Consultants and law firm Allen and Gledhill did the original feasibility study. The restructuring of Singapore Telecom, and an enabling clause to allow for privatisation was encapsulated in a parliamentary bill gazetted on 1 April, 1992 called "The Telecommunications Authority of Singapore Act 1992." Essentially, the new law split the old TAS into three entities, namely 1) a reconstituted TAS as the regulator, promoter and developer for the telecommunications and postal industries (remaining a government Statutory Board), 2) Singapore Telecommunications Pte. Ltd., the public telecommunication licensee (which also retains the name Singapore Telecom), and 3) Singapore Post Pte Ltd, the public postal licensee and a wholly owned subsidiary of Singapore Telecom. The two new "private" companies remained wholly-owned Government companies under one holding company, MinCom Holdings. In July 1993, Singapore Telecom was placed under Temasek Holdings, the Government's largest holding company, in preparation for the first share offer. TAS reamins under MinCom Holdings.

Singapore Telecom had, by all reasonable estimates leading up to the first share offer, a market capitalisation of over S$20 billion (US$12 billion), based on previous years financial earnings and a modest (by international standards) price/earnings ratio of 20. This would make it the largest company to be listed on the Stock Exchange of Singapore (SES). Initially, it was announced that approximately 7% of the share equity of Singapore Telecom would be floated on the SES in the third quarter of 1993. The offer in fact came in late October with issues beginning trading on Nov. 1, 1993. Goldman Sachs was the lead coordinator for the international tranche along with

C.S. First Boston and Daiwa Securities among others, while a consortium of six Singapore Banks handled the local listing. Morgan Grenfell (Asia) Ltd has also been a co-manager of the deal.

Singapore Telecom had a paid up capital of S$321.5 million as of March 1991, and had accumulated surpluses of over S$5 billion by 31 March 1993. The organisation will continue to seek investments primarily outside of Singapore for its enormous cash reserves in order to offer growth opportunities to its shareholders. The majority of the surplus however, along with the proceeds of the share offering, revert of course to the Government.

Shares in Singapore Telecom have been made available to citizens of Singapore as well as foreign investors with an emphasis on spreading share ownership, on favourable terms, to the widest possible number of Singaporeans. A three tiered scheme was set up dividing the offer into what were called A, B and C shares. The 'A' share category was set up exclusively for Singaporeans which allowed them to use their Central Provident Funds (CPF) savings to buy up to 600 shares at a 5% discount off the initial S$2.00 set price (i.e S$1.90). Included in this offer was an additional 40% accumulated discount over a six year period which will be paid out in the form of additional "loyalty" shares. The Government also paid an additional S$200 into all current CPF accounts for the purchase of Telecom shares. Initially, 350 million shares were offered in this category, but due to the strong response, an additional 487 million shares were allocated. In total, 837 million shares have been allocated under the 'A' share category.

The 'B' share portion of the initial offer was also exclusively for Singapore citizens. The price was set at S$2.00 per share and Singaporeans could apply for 1,000 shares in this category. However, only 200 million 'B' shares were made available of which 40.7 million were reserved for Telecom staff. This offer was more than three times oversubscribed and the final allocation was an equal distribution of 200 shares to all applicants in this category.

The 'C' share offer was made available to foreign investors as well as Singapore citizens. This portion of the flotation exercise comprised initially of 550 million shares. 'C' shares were offered on a bid basis with a minimum bid price set at S$2.00. This represents an historical price earnings ratio of 30.3 and forecast price earnings ratio (based on the forecast net earnings per share for the financial year ending 31 March, 1994) of 27 times. The forecast gross dividend yield for 1994 is 1.3 percent.

The 'C' portion of the initial offer generated considerable interest both in Singapore and among foreign institutional buyers in particular. The accepted 'C' share bid price was S$3.60, an indication of the investment attractiveness of the company. This portion of the offer was more than five times oversubscribed with shares going to those who bid at or above the accepted bid price. A total of 650.48 million 'C' shares were finally allocated in the initial offer.

In sum, the Singapore Telecom initial share offer generated a market capitalisation of S$55 billion representing one-third of the total capitalisation of the SES and an historic PE ratio of 54.5%. The proceeds, S$4.3 billion (US$2.6 billion), revert to Temasek Holdings, the Government's lead financial holding corporation. No information is available on how Temasek Holdings will use the proceeds.

The Government of Singapore continues to hold the vast majority of the privatised company. The total final initial offer of 1.68 billion shares represents 11% of the total share capital of 15.25 billion shares. Even if a greater percentage of shares are sold in the future, it is likely that the Government will continue to hold at least a "golden share" for some time to come.

It is very likely that more shares will be offered in the future. This will follow the step-wise privatisation plan in tranches that is characteristic of the privatisation of British Telecom upon which the Singapore process has been modeled at least at a macro-level.

4. REASONS FOR PRIVATISATION

The decision by the Government to privatise Singapore Telecom was not due to the need to change telecommunication policy itself, or overcome inefficiencies often associated with other telecommunications authorities. Rather, it was intended to support the national financial institutions including government holdings and add to the overall economic performance of the nation. As such, models of privatisation which have largely come from the U.S., U.K., Japan and more recently, Australia and New Zealand, are largely inappropriate to Singapore especially in terms of subsequent regulatory revisions.

A number of factors have contributed to the cautious approach to privatisation in Singapore. A continuing commitment to State ownership on political and economic grounds is a component of the Government's view that it is already providing the best service possible. In Singapore in particular, there is also a

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questioning of whether or not competition from one or more other carriers will in fact undermine the already substantially credible services offered at what are described officially as reasonable prices through the monopoly carrier. For domestic wireline services in any case, a serious arguement for competition may be largely irrelevant in a country the size of Singapore.

The goals which Singapore wishes to achieve in privatising Telecom are to provide better management incentives, remove day-to-day operations from the national policy process and to accelerate innovation and capital investment, thus allowing Singapore Telecom to expand internationally. To this observer, it appears the Government has carried through its pro-active policies of engendering economic growth by leveraging the success of the company. Not only do proceeds of privatisation go to the Government's holding company for further investment purposes (without public scrutiny), but the equity the Government continues to hold in the company, now poised for further expansion, should continue to increase in value. There is also a substantial amount of local political goodwill built-in as well. What has proved to be a very popular share offer to Singaporeans certainly does no harm to the ruling party's near absolute control. There are now approximatley 1.4 million shareholders in Singapore, roughly half the population. Continued political continuity as well as company and national growth are the bottom lines.

Underlying the major thrust of the economic reasoning for future growth of Singapore Telecom via a privatisation mechanism, is the strategic positioning of the Singapore economy in general and Singapore Telecom in particular to take advantage of future high technology developments. The newer technologies do not provide sufficient scale or scope in the local economy in the way POTS (plain-old-telephone- service) has for justifying a monopoly carrier. In order to develop and deploy advanced technologies, as part of the overall strategic economic motivations, there is a need for greater interdependence with networks of other countries to provide economically viable services. With increasing pressure to provide private networks to meet advance services needs elsewhere, Singapore Telecom will take advantage of being a private player with strong government support in the international arena for such developments.

5. A SINGAPOREAN APPROACH TO REGULATION

With the implementation of the Telecommunications Act of 1992, the Telecommunication Authority of Singapore, TAS, is now separated from the operating companies of Telecommunications and Posts. Whereas this separation in the European and North American models is seen as an "arms length" approach between the regulator, operator and policymaker (Government Ministry or Department), with the regulator given considerable autonomous powers, the Singapore approach still interweaves all three. In fact, the legislation preserves the Ministry of Communication's role in acting through TAS and Singapore Telecommunications Pte Ltd. The TAS has in addition to its nominal regulatory role, a mandate to promote Singapore's telecommunication sector. This dual role of regulator and promoter is highly unusual and it remains to be seen if future circumstances will call these roles into conflict.

The TAS is endowed with approximately half of Telecom's accumulated surplus. The TAS may also receive Ministry of Communications monies and may receive revenue from the levy of licenses and administrative fees as it sees necessary. Subject to Ministry of Finance approval, it may also raise money by the issuance of shares and bonds.

The Singapore approach to pricing is another of its unusual regulatory features. Rather than using rate of return, price cap formulas or other publicaly accountable pricing mechanisms, the TAS takes an internal "price comparison" approach with a benchmark of being "amongst the lowest three" in price comparison to services offered in other countries. Officially, the TAS is to assess, on a quarterly basis, the appropriateness of Telecom's rates on the basis of comparison with those of Singapore's neighbouring countries, major international financial centres and newly-industrialising economies. This managed, if vague, price comparison approach is supposed to take into account the impact of various price changes on the cost-of-living of the average Singaporean. In December 1991, a tariff rebalancing took place which in effect enhanced this price comparison approach at least temporarily in the domestic market. In it, the adoption of time-based charges with a decrease in the annual flat rate for services has had the net effect of maintaining or actually reducing monthly bills for nearly two-thirds of Telecom's domestic residential customers. Total domestic revenues have not fallen dramatically as a result however, as customers with higher usage patterns are faced with increased bills even though the pricing rate is supposedely low on a comparative basis. Depending on which comparison one chooses of course, domestic rates may be seen as rather high, especially in comparison to Hong Kong, which does not charge for local calls at all.

Officially, the price comparison approach is also attached to the quality of service which must meet or exceed the benchmarks set by the TAS. Such benchmarks are apparently not publicaly available however. Since prices supposedly remain below those of competitor countries, the TAS has indicated that it will not intervene in Telecom's pricing decisions thus giving TAS a very light-handed approach for now. Recently, price cuts for international services in both Hong Kong and Japan have prompted a modest reduction of direct dial international rates to a few select countries from Singapore. Since the setting of tariff rates is so vaguely defined, the lack of a clear public pricing policy to which the monopoly carrier would be accountable, unfortunately means it does not readily answer openly to anomolies which result. For example, the allocation of redundant services (backup lines) for large business customers is a source of irritation among some business users in Singapore. While actual per line rates may be officially "reasonable," the inflexibility of having to lease completely two or more separate lines for redundancy purposes in effect at least doubles the cost to the customer. This has happened to a large banking institution which recently relocated its Asia headquarters from Hong Kong to Singapore. The company claims that its telecommunication bill is now double that of previous bills in Hong Kong.

As it stands now, there are really no formal guidelines for what might be considered a tariff policy in Singapore. Such guidelines may not be developed if the present close relationship between the government, regulator and operator persists. However, this may eventually become a drawback to the Singapore system; The effect of which could be felt in terms of Telecom's long-term competitiveness.

Nonetheless, with licensing powers also now vested in TAS, the first cracks to Singapore Telecom's monopoly over all services may be appearing. While Singapore Telecom has a 15-year exclusive license for all basic services until 2007 (which will automatically continue on a non-exclusive basis until 2017), enhanced and value-added services are evolving slowly toward a more liberalised state. Recently, the TAS has taken a few small steps by liberalising the rental market for mobile telephone handsets following its previous decision to liberalise coin pay-phones. Telecom also has a five year monopoly license to provide land-based mobile communication services which expires in 1997. Preliminary indications already are that a second mobile operator license may be forthcoming at that time.

6. CONCLUSIONS

The very close link between government, regulator and operator in Singapore must be seen not in terms of conflict of interest, at least in the short run, as might be the case in other countries. Rather, it is a tripartite strategy for development opportunity. Already, this arrangement is pushing for the installation of a complete fibre optic network "to the curb" by 1996. The question remains as to how far this managed approach of encouraging technology development and then ensuring market success can go especially in the absence of any real market competition outside of the CPE market. How this approach will be perceived internationally as Singapore Telecom expands will also determine, in part, its future success. Since Singapore Telecom is expecting a certain openness in the markets of other countries in order to engage in the trade of telecommunication services, it is not unreasonable for others to expect such an open market in Singapore. Whether Singapore can maintain its position vis-a-vis such reciprocity issues will provide a challenge to its form of regulatory control.

To be fair, however, the success of the Singapore approach to privatisation in telecommunications to date and its subsequent regulatory arrangements has to a large degree depended on a "good government" ethic. With a concerted effort by the Government toward economic development within a framework of a meritocratic and relatively corrupt-free operating environment, Singapore has shown what is possible in terms of the development of an extraordinarily strong telecommunications infrastructure. Singapore does not have to contend with a large geographic area, large population, rural sector or other large-scale undevelopment problems characteristic of many of its regional neighbours. It has therefore been in the enviable position to invest in and reap revenues from a monopoly position of the most lucrative of urban concentrations for telecommunications. With Singapore's emphasis on basing multinational companies to provide for robust economic activity, subscriber line density has built up rapidly among other reasons. Revenue surpluses have mounted quickly as there has been no need to cross-subsidise or otherwise debt-finance less lucrative telecommunication infrastructure as is the case in most other developing countries.

The lessons to be learned from the Singapore example are, however, not to be diminished. Certainly a strong decision-making polity has allowed Singapore to plot its economic and social course with relative impunity. More importantly, however, has been a strong measure of ethical government motivations in the development of the nation and its various institutions including telecommunications. This aspect should not be forgotten despite debate which may ensue over various methods and practices. In many parts of the developing world, this basic precondition for efficient economic development remains elusive quite apart from any structural differences there may be from Singapore as a specific case. It is interesting to note that many of the recommendations from the Report of the Independent Commission for World-Wide Telecommunications Development (ITU, Dec.'84), known as the Maitland Commission report entitled "The Missing Link," revolve around simply committing to various aspects of telecommunication development as a national priority. The Singapore example of telecommunications development should be seen therefore not necessarily as a model to copy in terms of tactical detail but as a successful example of the strategic interest which can be developed out of a larger commitment to motivated development lead by strong, largely uncorrupted leadership in the Asian authoritarian style. This indeed has been one of the hallmarks of Singapore's extraordinary economic success as a nation.

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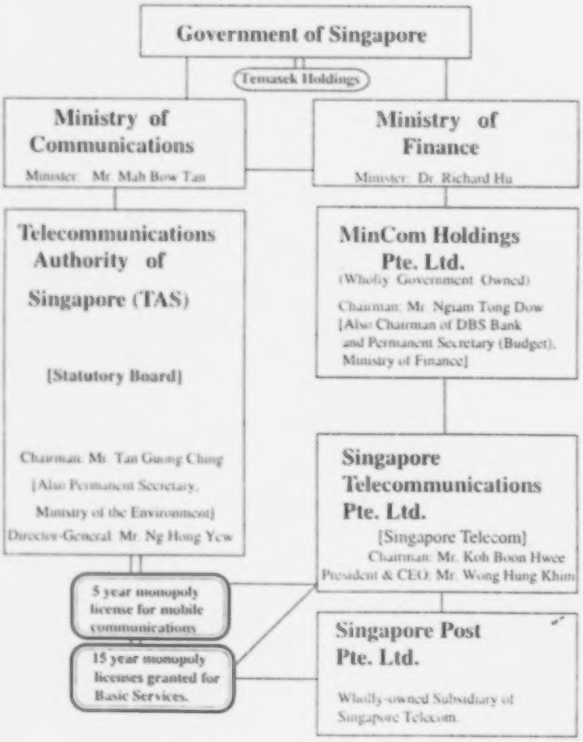
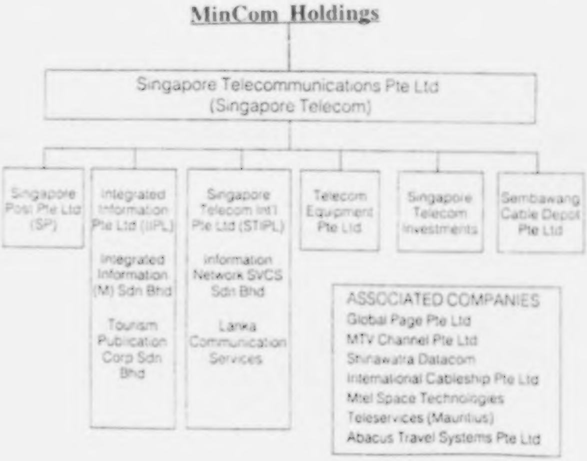
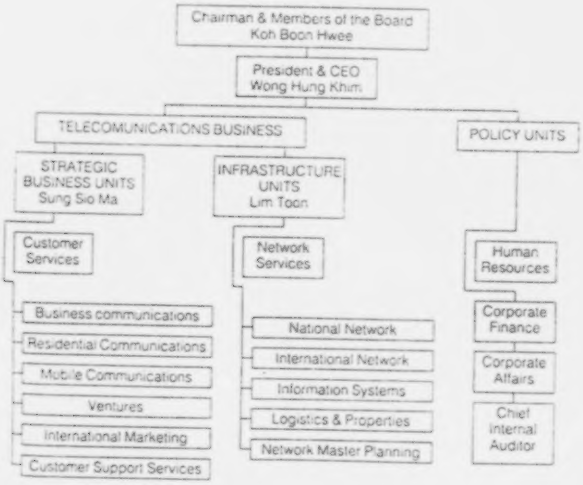

Government of Singapore
Temasek Holdings
Ministry of Communications
Minister: Mr. Mah Bow Tan
Ministry of Finance
Minister: Dr. Richard Hu
Telecommunications Authority of Singapore (TAS)
[Statutory Board]
Chairman: Mr. Tan Guong Ching
[Also Permanent Secretary, Ministry of the Environment]
Director-General: Mr. Ng Hong Yew
MinCom Holdings Pte. Ltd.
(Wholly Government Owned)
Chairman: Mr. Ngiam Tong Dow
[Also Chairman of DBS Bank and Permanent Secretary (Budget), Ministry of Finance]
Singapore Telecommunications Pte. Ltd.
[Singapore Telecom]
Chairman: Mr. Koh Boon Hwee
President & CEO: Mr. Wong Hung Khim
5 year monopoly license for mobile communications
15 year monopoly licenses granted for Basic Services.
Singapore Post Pte. Ltd.
Wholly-owned Subsidiary of Singapore Telecom.

As of September 1993.

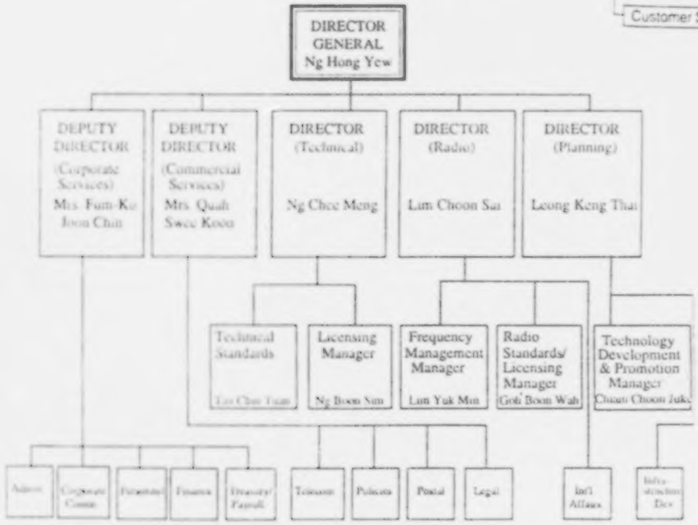
THE SINGAPORE TELECOM GROUP


MinCom Holdings
Singapore Telecommunications Pte Ltd (Singapore Telecom)
Singapore Post Pte Ltd (SP)
Integrated Information Pte Ltd (IIPL)
Integrated Information (M) Sdn Bhd
Tourism Publication Corp Sdn Bhd
Singapore Telecom Int'l Pte Ltd (STIPL)
Information Network SVCS Sdn Bhd
Lanka Communication Services
Telecom Equipment Pte Ltd
Singapore Telecom Investments
Sembawang Cable Depot Pte Ltd
ASSOCIATED COMPANIES
Global Page Pte Ltd
MTV Channel Pte Ltd
Shinawatra Datacom
International Cableship Pte Ltd
Mtel Space Technologies
Teleservices (Mauritius)
Abacus Travel Systems Pte Ltd

Organizational Structure of Singapore Telecom


Chairman & Members of the Board
Koh Boon Hwee
President & CEO
Wong Hung Khim
TELECOMUNICATIONS BUSINESS
POLICY UNITS
STRATEGIC BUSINESS UNITS
Sung Sio Ma
INFRASTRUCTURE UNITS
Lim Toon
Customer Services
Business communications
Residential Communications
Mobile Communications
Ventures
International Marketing
Customer Support Services
Network Services
National Network
International Network
Information Systems
Logistics & Properties
Network Master Planning
Human Resources
Corporate Finance
Corporate Affairs
Chief Internal Auditor

TAS Organisational Chart


DIRECTOR GENERAL
Ng Hong Yew
DEPUTY DIRECTOR (Corporate Services)
Mrs. Fum-Ku Joon Chin
DEPUTY DIRECTOR (Commercial Services)
Mrs. Quah Swee Keow
DIRECTOR (Technical)
Ng Chee Meng
DIRECTOR (Radio)
Lim Choon Sai
DIRECTOR (Planning)
Leong Keng Thai
Technical Standards
Licensing Manager
Ng Boon Sim
Frequency Management Manager
Lim Yuk Min
Radio Standards/ Licensing Manager
Goh Boon Wah
Technology Development & Promotion Manager
Chuan Choon Juke
Admin
Corporate Comm
Personnel
Finance
Treasury/ Payroll
Telecom
Policies
Postal
Legal
Int'l Affairs
Infra-structure Dev

Source: TAS

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TUSITALA: ECHOES IN THE SOUTH PACIFIC

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ABSTRACT

As the world has become increasingly linked by trade, the demand for reliable and cost-effective communications has grown dramatically. There has also been a fundamental change in the culture and role of telecommunications in society. The paper looks at the promise offered by the Maitland Report and the tremendous changes that have occurred over the last ten years. In particular, it focuses on changes that have occurred in the South Pacific island countries, and proposes new links which need to be forged to capture the opportunities emerging over the next ten years.

1.0 FROM MAITLAND TO MELANESIA

1.1 The Way We Were

It is now ten years since the Maitland Commission presented The Missing Link - Report of the Independent Commission for World-Wide Telecommunications Development. There have been so many developments and fundamental changes world alignments, that the severity and suddenness of their impacts have left administrations floundering. It is very difficult, today, to remember the way we were back in 1984 and the pressures that gave rise to the Maitland Commission.

The driving force for telecommunications development was the gross imbalance in the distribution of telephone services, as outlined in The Missing Link (1):

> *"75% of the world's 600 million telephones are concentrated in nine countries, and the remainder are distributed unevenly throughout the world."*

The commitment and determination to deal with these issues originated from the highly successful Plenipotentiary Conference of the International Telecommunic-ation Union (ITU) held in Nairobi in 1982. The "Plenipot" had created a climate of tremendous goodwill among the participating nations, and there was a collective willingness to focus on the needs of developing countries.

The enthusiasm generated by the Plenipot was harnessed by Dick Butler, the (then) Secretary-General of the ITU who personally persuaded, cajoled and enticed key Administrations to become valued participants. He also commissioned a range of studies under the banner of *Telecommunications for Development*, to be undertaken in concert with the Organisation for Economic Cooperation and Development (OECD), to research the linkages between telecommunications and economic and national development.

The ITU also undertook a series of three major Regional Seminars on development issues, the last of which was held in the Asia-Pacific region (Kuala Lumpur) in December 1983. In presenting the ITU/OECD Synthesis Report, the Secretary-General noted (2) that an objective of the study had been to dispel preconceived ideas about telecommunications development.

In particular, Jequier and Pierce, who conducted the study (3,) observed that investment in telecommunications was "not fashionable". Their studies showed:

- Development Planners tend to view it as socially less important than rural development, health services, education, energy generation, or irrigation systems, and primarily of interest to urban areas and the wealthier strata of society which makes no visible contribution to raising the standard of living of the population as a whole, particularly in rural areas;
- International Development Banks tend to view it as a minor carry-over from the days when they were heavily involved in the building up of public utilities;
- Economists almost totally ignored it, except when they had been contributing to the view that it was a luxury, which a country could afford to indulge in once other more important needs had been satisfied.

That limited perspective led to significant under-investment in telecommunications. This situation is presented graphically in the sectoral distribution of World Bank Group Loans over the period 1975 - 1980 (4), shown in Figure 1.

A revolutionary finding of the study, which went very much against the conventional wisdom, was that *telecommunications are a major contributor to growth, particularly in the poorest countries and regions*.

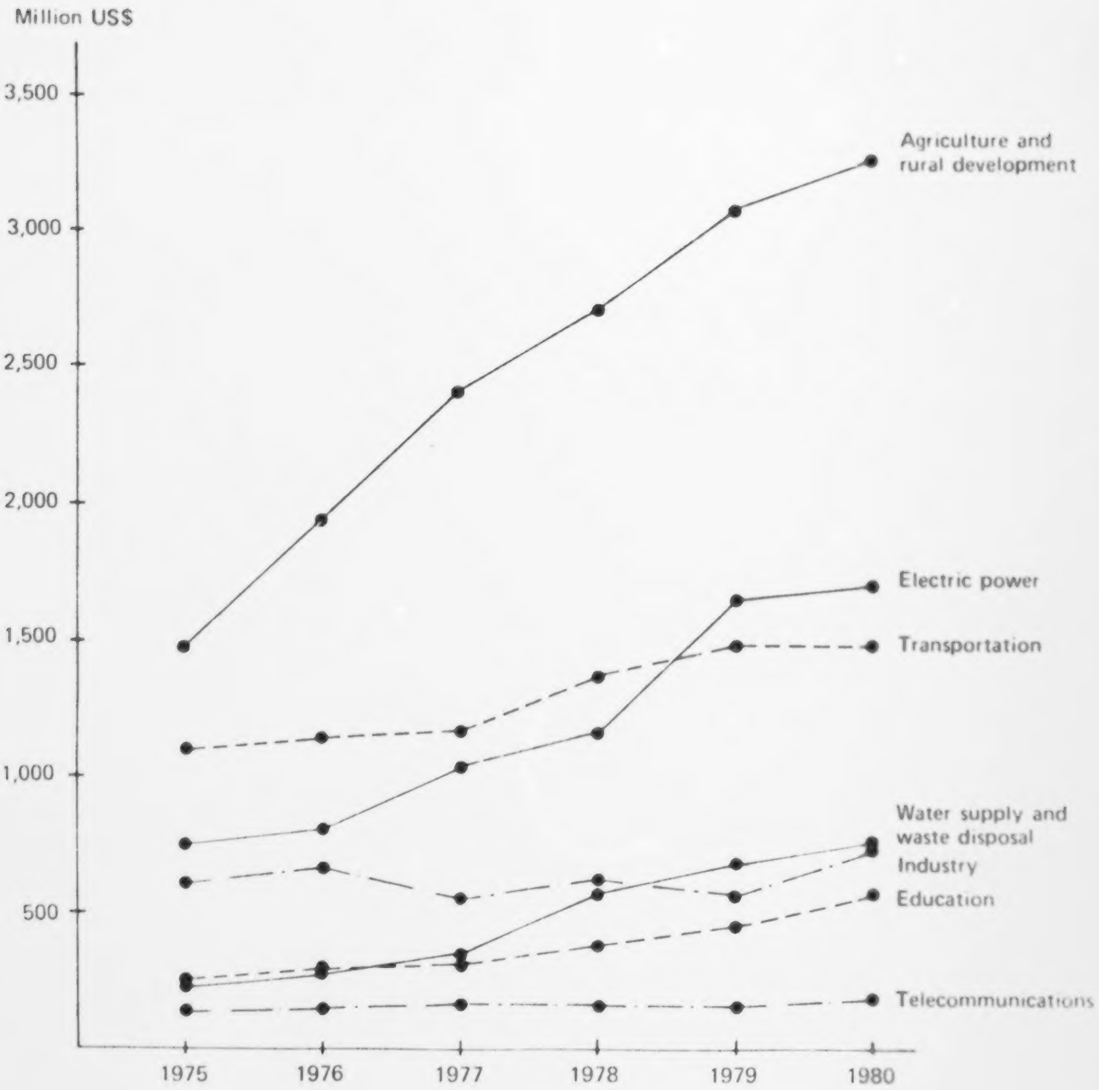
1.2 South Pacific Developments

In the South Pacific region, Australia, New Zealand (NZ) and the United States (US) were taking a particular interest in telecommunications development. At the request of the South Pacific Bureau for Economic Cooperation (SPEC) and the enthusiastic urging of Dick Butler, Australia with NZ funded and conducted a major engineering study of the telecommunications needs of the Island countries.

The findings resulted in a proposal for the establishment of a cooperative South Pacific Telecommunications Development Program, which was endorsed by the Heads of Government at a meeting of the South Pacific Forum in Canberra in 1983.

Figure 1

SECTORAL DISTRIBUTION OF WORLD BANK GROUP LOANS, 1975-1980



Source: World Bank Annual Reports.

Notes: The data used here are three-year averages.

The seven sectors presented in this figure amount on an average to 80 percent of the total loans of the World Bank Group.

In the 1969-73 period, telecommunications accounted for 5.4 per cent of the World Bank Group loans. In 1974-78, for 2.3 per cent, and in 1979-81 for 1.7 per cent.

At the same time, the US Public Service Satellite Consortium (PSSC) was conducting a Pacific Basin communications study for the National Aeronautics and Space Administration (NASA) and the National Telecommunications and Information Administration (NTIA). This study placed an emphasis also on user requirements in relation to the development of social services and commercial activities in the region.

The International Telecommunications Satellite Organisation (INTELSAT) was also undergoing metamorphosis. Suddenly it was not the world monopoly provider of bulk satellite capacity, but the champion of developing countries, guaranteeing their access to the geostationary orbit. It was also packaging thin route service offerings for developing countries for less than one transponder - even 1/10 of a transponder! Potential competition from private satellite systems had arrived.

1.3 The Maitland Commission

It was in this environment of goodwill and desire for positive action that the *Independent Commission for World-Wide Telecommunications Development* was established under the chairmanship of Sir Donald Maitland. The Commission considered many submissions, including those from the ITU *Telecommunications for Development* studies and the outputs from the Regional Seminars.

The findings of the Maitland Report were not new nor were they a surprise. Their value and major contribution was that for the first time such conclusions had been brought together by a competent, independent body, supported by soundly based research and case studies. Some of these conclusions were:

- **an efficient telecommunications system confers significant economic and social benefits on a community or nation;**
- **no development program of any country will be balanced, properly integrated, or effective unless it accords telecommunications an appropriate role;**
- **profitability is an inappropriate criterion for investment in telecommunic-ations in remote areas.**

The recommendations covered a range of initiatives, including the establishment of the Centre for Telecommunications Development and a strong emphasis on training. To sustain development, the Commission recommended that:

- **developing countries should make telecommunications a priority in their development aid plans and proposals; and**
- **the United Nations Development Program (UNDP) should give more priority to telecommunications in its funding.**

There was a clear expectation that aid funding would play a significant role in the development of telecommunications services for developing countries.

2.0 THE DECADE OF CHANGE

2.1 Deregulation and Liberalisation

What a decade of change it has been! Fuelled by the blistering pace of technological change and the increasing internationalisation of commerce, the demand for telecommunications services has driven huge changes in the quality and extent of networks and service offerings - at least in the industrialised countries.

Businesses have become very dependent upon reliable, cost-effective telecommunications services, recognising the need to match those of their international business partners and clients. Consequently they have demanded more tailored value-added services, and have expected greater responsiveness on the part of the service provider or carrier. The lowly "subscriber" now has rights!

These pressures have led to significant liberalisation of the telecommunications regimes around the world, many examples of which have been discussed here at PTC. These changes have ranged from divestiture in the US, to structured competition in Japan, re-regulation and privatisation in the United Kingdom (UK), deregulation and privatisation in NZ, and a unique form of transitory managed competition through a duopoly in Australia.

Several of the newly industrialised countries in the Pacific region have contemplated the extent of liberalisation and privatisation that they should pursue. It is a particular challenge to developing countries to identify a model that could meet their unique requirements, as their geographic, commercial, regulatory and social environment is quite different from that prevailing in industrialised countries.

In the South Pacific, a number of countries have adopted the corporatisation path towards liberalisation and privatisation. These include Tonga, Fiji, Papua New Guinea, Federated States of Micronesia, Kiribati and the Cook Islands. While the experience of each country has been different, it is significant that each has decided to move away from the traditional European PTT model for the delivery of posts and telecommunications services along which they have developed for many years.

The richness and variety of telecommunications service offerings available to the business user in developed countries has never been greater and the prices never more competitive. The service providers and carriers have never been more responsive to meeting client needs and the unresponsive "subscriber" attitude is fast disappearing. Flexibility, customer service and quality are rapidly becoming part of the new competitive environment.

But this has not been the case in the developing countries of the Pacific region.

2.2 The Trade Winds

"The Trades" blow fitfully in the South Pacific. Wild storms and hurricanes can leave adjacent islands and even villages untouched. While some advances have been made in the reach of the telecommunications network, and particularly in the improved quality of telecommunications services available in prime regional centres, the modest objective of providing at least a "village phone" to 5% of the rural community by the year 2000 seems little closer.

It is a paradox that while there may be excellent communications with distant countries from the major cities via undersea cable or INTELSAT, it is often impossible to communicate with the village in the next valley. It would seem that despite the Maitland Report, planning bodies are little more concerned today about the need to make investment in telecommunications a priority, than they were ten years ago.

This neglect has entrenched the problems with bilateral aid, where priorities are determined by the recipient country. If the planning bodies in the recipient country have not accorded priority to telecommunications, the donor country is no more able to influence that outcome than it was ten years ago. The entrenched attitudes and perceptions so clearly identified in the ITU/OECD study ten years ago, seem to have endured remarkably well!

Meanwhile, the imbalance in the global distribution of telephone services, so graphically drawn to the attention of the world by the ITU, largely remain: silent echoes in the South Pacific, like the tales of Robert Louis Stephenson, the Tusitala of Western Samoa.

3.0 TAKING STOCK OF THE OUTCOMES

3.1 Revisiting the Maitland Report

So what happened to the promise of the new dawn articulated by the Maitland Report? Was it all illusory? Well, no - not really. By and large the findings of the Commission were sound and the Report described the problems very well. Perhaps a weakness was that **the Report itself** was cast indelibly in the mould of the attitudes of the day.

The recommendations of the Maitland Report were cast in the implicit expectation that the development and funding of telecommunications would continue much as it had before, and there would be a significant dependence on aid programs. These expectations shaped the recommendations that the UNDP and the developing countries planning bodies should make telecommunications a priority in development programs. That has not happened.

Looking back over ten years and the unprecedented structural and regulatory changes that have occurred in the world fabric of telecommunications, the pace and extent of change has been incredible. These could not have been foreseen by the architects of the Maitland Report. And it is these changes that have widened the gap between the developed and developing countries.

There has been a fundamental cultural shift in the role played by telecommunications in industrialised countries, which are trading increasingly in world markets. In those countries, awareness of the intrinsic value of telecommunications not only in commerce but also to society as a whole has never been higher. That awakening, however, has not generally been shared by the planning bodies of developing countries.

Ignorance about the catalytic role played by telecommunications in development would seem to be endemic to the "softer sciences". A surprising example arose recently in the July-August 1993 edition of East-West Centre Views (5), which reported that development issues were debated at the Fourth Pacific Islands Conference of Leaders held in Tahiti in June 1993.

The leaders from 22 Pacific Island states called for a range of actions, including more emphasis to be placed in the research undertaken by the Pacific Islands Development Program (PIDP) at the East-West Centre in Honolulu, on how issues such as economic development, migration, population growth, technology and environmental protection interrelate and affect sustainable development within the Pacific Islands.

The significant omission from these discussions was that no role whatsoever was identified for telecommunications.

However, given the huge increase in demand for telecommunications services and the high capital intensity of the investment, aid funding could not possibly have met the requirement. Indeed, it is most unlikely that the total capital requirements could be met by the public sector. These revolutionary changes in the telecommunications environment have fundamentally changed the way in which telecommunications services will develop in the future.

3.2 The Missing Link

These major changes have been reinforced by the convergence of the technologies of telecommunications, information technology and broadcasting, and also by the increasing integration of these services. Almost everyone has now been introduced to the exciting new world of Multimedia! And the impacts are growing daily.

What seems to have escaped notice is that we are also seeing the convergence of users and cultures (6), reflecting a burgeoning demand for telecommunications services by all sectors of the community. These demands have been passed on to the developing countries as their overseas trade and commercial links have grown. The resulting developmental pressures have highlighted the deficiencies of the telecommunications networks in the developing countries.

Responding to these economic imperatives, the South Pacific countries have pursued liberalisation and corporatisation of their telecommunications carrier. As the full extent of the huge requirement for network development begins to be defined, however, it has clearly shown up the **real** Missing Link: **capital**!

4.0 FORGING NEW LINKS

4.1 The Next Ten Years

Around the world, the demand for telecommunications services over the next ten years will continue to grow dramatically. We can also expect many Pacific Island populations to continue to grow at an annual rate of almost 3 % (7), which will make the development of rural and remote area telecommunications even more pressing.

Funding is a major issue for developing countries. The capital intensive nature of telecommunications investment places an impossible demand on the nation's scarce reserves of foreign exchange to purchase network equipment and systems. Such decisions would need to be agreed with the Ministries for Finance, Trade and Commerce, which have shown themselves to be "traditionalists" and unlikely to view the proposals sympathetically.

There is unlikely to be any significant change in the attitudes of national development planners or the international aid agencies. Consequently, new approaches must be developed to bridge the real Missing Link (capital). New links must be forged to take the developing countries of the Pacific successfully through the next ten years.

Some of the key initiatives which could be taken, and the issues associated with them are discussed in the following sections.

4.2 Privatisation

Under the loose label of "privatisation", the debate over the last ten years has ranged over liberalisation, commercialisation, corporatisation, deregulation, re-regulation and globalisation. But they are not the same.

There is nothing inherent in the change of ownership, for example, of a Government Business Enterprise (GBE) to the private sector, that will necessarily increase efficiency and effectiveness. If ownership is the only thing to change, with no accompanying liberalisation of the regulatory controls, then there is no reason to believe that the operation of the GBE will be any different.

There are a number of reasons why Governments may wish to consider privatisation of a GBE. Most of these reasons draw heavily on the popularly envisaged consumer benefits, including lower prices and claimed increases in efficiency and effectiveness. But it is rarely made clear how these benefits will actually occur. Let us explore some of these reasons.

i. Political Conviction

Ideological convictions tend to reflect a wide range of political considerations. While there may not be any particular concern about a GBE's operations, there is usually a strongly held belief that such services should be provided by the private sector. And that privatisation will, somehow, enhance competition and deliver wider user benefits.

ii. Business Expertise

Governments may wish to privatise a GBE which is operating in a highly specialised business and technologically demanding environment, and is seen to require a level of operational and management expertise not generally available in a Government entity.

iii. Circuit Breaker

A Government-owned GBE operating for many years may have developed a culture and business practices which are increasingly incompatible with the demanding commercial environment of the 1990s. Work practices and structures may have become firmly entrenched, and the organisation may be resistant to change. In these circumstances, the Government may wish to send a clear message to the organisation and to the industry that it is serious about change.

iv. Sale of Assets

Governments running a large overseas debt are faced with a tremendous temptation to sell off assets to fund their deficit, and reduce overall Government spending by getting major expenditures off-budget. While this option may seem attractive, the "business" objectives of Government are never simple or straightforward. The operations of a telecommunications GBE generally serve a multiplicity of policy objectives and involve a wide range of public interest and social equity considerations. This situation is particularly relevant for a developing country.

v. Access to Capital

Perhaps the most pressing reason for privatisation of a GBE in the 1990s is to free up its access to capital (8). Telecommunications Authorities operate huge assets and their demand for capital to support the on-going maintenance, replacement and development of the telecommunications network is vast. This huge and continuing demand for capital could not be met by public sector funding or by aid agencies.

Should the Government wish to privatise the Telecommunications Authority, it has a real dilemma in presenting the asset for sale: whether to cut the string and liberalise the environment to maximise competition and attract the highest price for the asset; or to float (say) 49% of the company, reduce competition, and reduce the value of the asset further by retaining a controlling interest.

Experience shows that Governments love to meddle - they simply cannot let go! Consequently investors would be concerned about the Government retaining a controlling interest (for example, through a special rights preference share or "golden" share), and possibly seeking to stack the Board with their "mates". Private sector investors would not be attracted to an enterprise that was weighed down by a mantle of onerous and restrictive public sector controls and accountabilities.

On the other hand, there are potential dangers in freeing up the enterprise too much! By removing **all** public sector controls, the Government would no longer be able to exercise its powers to support social equity objectives and to use the telecommunications authority to pursue other policy goals. Finding the balance is a challenge!

In contemplating its decision, the Government must remember that the act of selling off an enterprise does not, in itself, make the enterprise more efficient or competitive. **If nothing else changes**, all that has happened is that a public monopoly has been replaced with a private monopoly.

4.3 The Regulatory Environment

The Government must first clarify its goals for privatisation and decide to what extent it wishes to maintain control of the operating environment. In effect, the Government needs to determine the competition policy it wants to follow, because to be successful, privatisation must be accompanied by a level of liberalisation of the regulatory environment.

These considerations need to be linked with the Government's policies for economic growth, trade and foreign ownership. It must recognise the impact that the regulatory environment will make on the level of foreign investment, and on the relative attractiveness of the asset to overseas investors. The regulatory environment in fact lays down the rules for development, competition and investment, and will also affect the rate and extent of network development.

The regulatory regime will be an essential part of the Government's "Prospectus" - its contract - for operating the enterprise in harmonious partnership with overseas investors, commercial organisations, service providers and equipment suppliers. The "Prospectus" is also their guarantee of confidence in the stability of the Government's regime, and of their investment.

4.4 Education and Training

Critical links that need to be forged to take the developing countries through the major restructuring and changes that lie ahead, are education and training. The lead times are long, and there are considerable lags in achieving the benefits. Existing machinery needs to be shaped so that it can provide the **right** kind of training and skills development for the future: for example, managerial training and financial management.

Ten years after the Maitland Report, there is still a need to educate the development planners and decision makers about the key role played by telecommunications in national and social development. The *Telecommunications for Development* studies conducted by the ITU/OECD a decade ago as inputs to the Maitland Commission, would still seem to offer an excellent starting point today.

To be successful today, education and training initiatives will need to focus on promoting strategic thinking and the formulation of development strategies. This is a new challenge for administrators and policy developers, who will need to integrate a wide range of economic, regional and social development policies with telecommunications development.

The developing countries of the Pacific cannot wait another ten years. They can no longer afford to ignore the messages of the Missing Link.

4.5 Relationships With Suppliers

No strategy for balanced telecommunications network development can be complete without providing for a close and professional relationship with the suppliers of telecommunications equipment and systems. At no time has this been more important than now.

The cost of developing equipment and systems is high, and the rapid rate of change of technology provides a continuing challenge. Network planners need to be aware of the capabilities of existing equipment and systems, and of what is "in the wings". Fortunately, driven by fierce global competition, suppliers have never been more responsive to understanding client needs and formulating cost-effective solutions.

A shared understanding of needs by the user and the supplier is particularly important for the developing countries of the South Pacific. Geographic factors, terrain, access and climate present unique challenges which need to be taken into account in the design of network equipment and systems. Further, the technologies employed will need to reflect the paucity of skilled technicians and depot level repair facilities, and often the restricted availability and high cost of reticulated power.

The importance of these linkages is at last being understood. A recent example is the Telecommunications Trade Fair and Seminar coordinated by the Telecommunications Division of the South Pacific Forum Secretariat, which was held in Suva in September 1993. It was well attended, with some practical presentations by suppliers.

On exhibition and demonstration were displays of new rural and remote area communications equipment, developed with the particular needs of developing countries in mind. There would seem to be growing opportunities for the South Pacific countries to forge new links and establish collaborative arrangements with equipment and systems providers.

4.6 Regional Cooperation

The basic links of regional cooperation are already in place. Organisations such as the South Pacific Forum have been operating for many years, and there are a number of other regional organisations. The most recent addition has been the Asia-Pacific Economic Cooperation (APEC) forum, which has become prominent in development issues.

APEC works through the various national Committees to the Pacific Economic Cooperation Council (PECC) embracing 20 economies in the Asia-Pacific region. In particular, the Transportation, Telecommunications and Tourism Task Force (the Triple-T Task Force) has sought to integrate telecommunications in its development deliberations, and organised the Pacific Telecommunications Roundtable in Honolulu in January 1993.

At the PECC conference (9) held in Fukuoka, Japan in 1992, Fukuoka was declared a "Triple-T City" with the introduction of a unique, integrated approach to its urban development plan. To promote the harmonised development of other cities in the region, the Japanese Committee will undertake research into the role of urban development in transportation, telecommunications and tourism, using Fukuoka as a model.

It is interesting to note that, in 1992, the Task Force offered the following policy recommendations:

- **In their economic planning, economies need to place greater emphasis on the development of transportation, telecommunications and tourism infrastruc-ture and the formation of international networks.**

- **Governments will need to give priority to investment in transportation, telecommunications and tourism, and it will be necessary to promote the balanced development of transportation, telecommunications and tourism infrastructure by improving coordination among government departments and agencies.**

Somehow, all that sounds very familiar! Indeed, other recommendations of the Task Force refer to **aid policies** and the **need to give priority to telecommunications in planning.**

The objective of Regional cooperation should be to learn from each other's experiences. In this regard, the Pacific Telecommunications Council is playing a valuable role by providing a professional focus on contemporary changes and developments. The path that emerges draws increasingly on "competitive cooperation" (10) in the Region.

4.7 The Linkages

Forging new links to cover the range of issues discussed above is exciting. The real challenge, however, is drawing all of these together and establishing the necessary linkages between them to make them work!

Priority should be given to formulating a Development Strategy for each country to give clear guidance to the linking process, and preparing a practical and dynamic Implementation Plan to achieve their objectives. This may seem a daunting task to many developing countries, which tend to be locked into the traditional planning cultures.

It is unlikely that such planning bodies could change their perceptions of investment priorities sufficiently to develop a dynamic and flexible strategic vision. Without the vision, the strategic plan will not have substance.

Faced with this dilemma, Governments will need to engage expert professional assistance. There are many consultants who have considerable skill and experience in dealing with strategic planning issues. The ones to be preferred, however, will also know how to apply their skills to guide and develop the Government's own planning team.

It is imperative that sound judgements be made in appointing a Consultant. There must be not only a shared understanding of what the future benefits might be to the nation, but also of what is at stake. A plan might be sound in commercial and technical terms, but unless it fits comfortably with the culture and particular circumstances of the country it will fail in the long run.

The simple goal for each nation will be the harmonisation of communications and culture in a rapidly changing world.

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A TELECOM DEPLOYMENT STRATEGY FOR MAXIMUM NATIONAL BENEFIT WITH MINIMUM EXPENDITURES

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1. ABSTRACT

Telecommunications competes for funding with other infrastructure needs in developing countries, and funds assigned have usually been spent constructing plant in traditional (i.e., that used in developed countries) patterns. The authors propose a different approach, advocating that less money be spent on traditional exchanges, more be spent on certain enhanced business services, and that a combination of modern public telephones and a national voice mail service be used to provide a 'virtual universal service.'

2. Introduction

Telecommunications is a critical element of the infrastructure needs of any developing country. This is true not only to provide support for the growing economy of the country, but is essential for social and cultural development as well. Indeed, as the Maitland Commission Report noted, telecommunications contributes to a society in many ways, such as facilitating emergency and health services, acting as a channel for education and the general dissemination of information, reducing the need for travel (and thus congestion and pollution), encouraging self reliance, strengthening the social fabric and sense of national identity, and contributing to political stability. (See Figure 1).

Why then, given such an understanding, does investment in telecommunications infrastructure often lag behind that in other sectors, as shown in Figures 2 and 3? While national policies and other factors can certainly contribute to this situation, the authors believe the primary explanation has to do simply with shortages, both of investment capital and of trained staff for operations and maintenance. Most telecommunications administrations in developing countries have looked at the infrastructure in more advanced countries, and how it was constructed, and have assumed their planning should follow suit. In this context, new switching systems are installed in areas of unserved demand, with the highest priority sites chosen perhaps on a basis of population density, held order lists, or some other similar factor. This usually entails the concomitant construction of new exchange buildings and associated acquisition of land. The availability of switching capacity then leads to expenditures for both loop plant and for additional interexchange trunking facilities connecting the new exchange with the existing network.

3.0 Alternatives Considered

Recognizing this situation, some suppliers have recently proposed various techniques for using radio-based technologies, such as cellular, PCN, and fixed rural systems, as an alternative to the construction of traditional wireline facilities. While these approaches have merit in that they may allow a given budget to be "stretched" somewhat, it must be remembered that these techniques principally address only the loop plant portion of the budget, as switching and interoffice trunking facilities must still be provided. It has also been noted that an aggressive program to install public phones can be helpful, but as Figure 4 shows, this approach also has drawbacks.

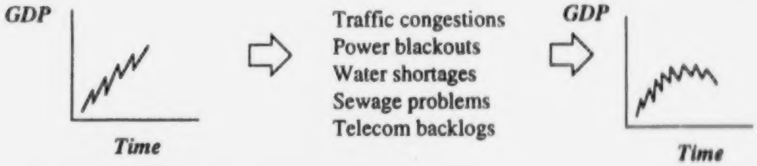
4.0 A New Approach

The authors believe a radically different approach to the national planning of telecommunications services, and the related allocation of scarce resources, can provide many developing countries with the greatest benefit much sooner than would be possible following the traditional patterns. Specifically, we propose that new exchanges serving primarily residential areas of demand NOT be built, and that funds and personnel be redirected to providing certain enhanced business services. At the same time, to achieve many of the social, educational, and cultural goals mentioned above, we recommend the provision of a nationwide voice mail service available to ALL residents and businesses, coupled with the widespread deployment of modern public telephones. (Figure 5.) This plan explicitly recognizes that funds devoted to facilities and services supporting business expansion and increased efficiency have a greater "multiplier" than those spent on residential services, and at the same time, makes a "virtual universal service" for basic communications readily and quickly available to every citizen. The economy is thus maximally stimulated, while the

Situation in Developing Countries

Figure 1

Economic success strains infrastructure which then threatens to retard growth



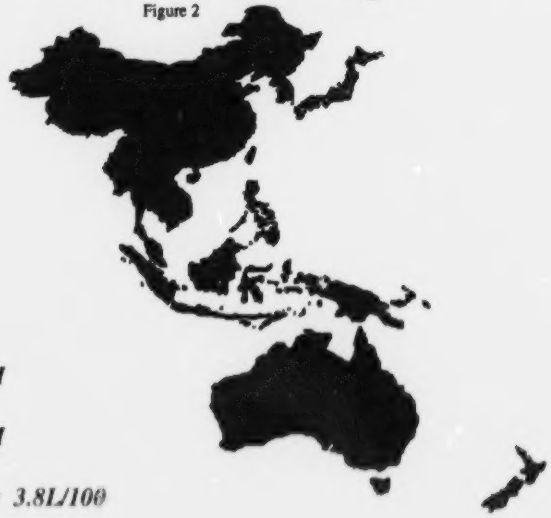
Traffic congestions
Power blackouts
Water shortages
Sewage problems
Telecom backlogs

Telecom investment has the highest leverage for scarce resources

But: Traditional solutions are slow, costly, business oriented	Needed: A creative solution for "universal" service
Wireline exchanges	Fast deployment
Cellular	Low cost per person
Wireless	Meets social and voter agenda
Urban bias	Easy to migrate to conventional uses

Asia/Pacific Example

Figure 2



Population: 3045M

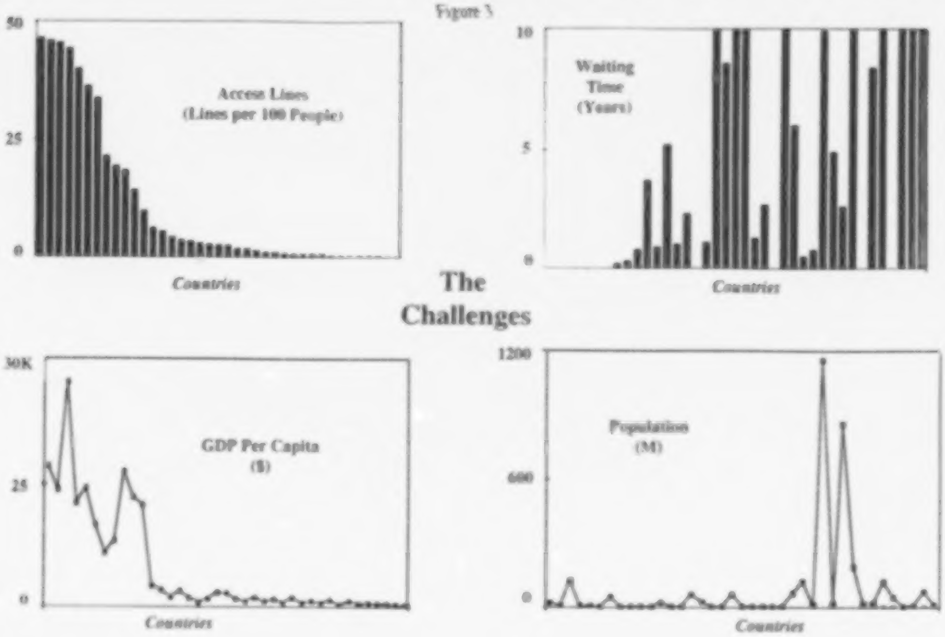
Access Lines: 116M

Access Line Density: 3.8L/100

Pacific
Telecommunications
Council **Telecom Deployment Strategy** **Honolulu, Hawaii**
January 17-20 1994

The Challenges

Figure 3



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Telecommunications
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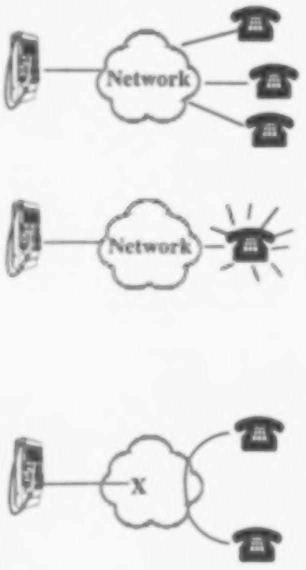
Public Phones Are Not Enough!

Figure 4



Public Phones enable many users to share scarce facilities

But.....

Require the called party to have a phone

Uncommon in developing countries

And....

Do not solve the "line busy" problem

Common in developing countries

Proposed Solution: Public Phones Plus Voice Mail

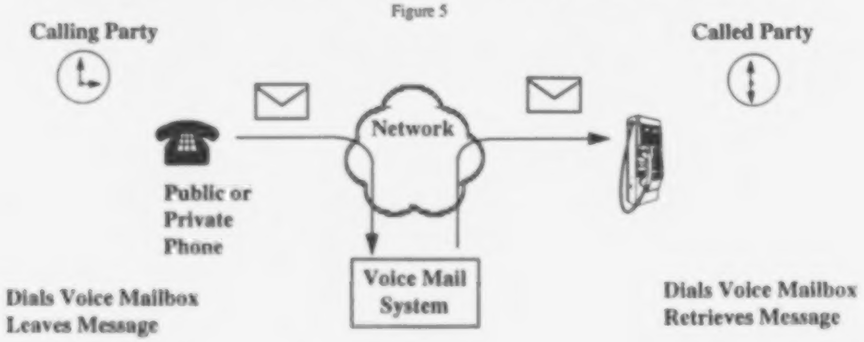

Calling Party
Called Party
Network
Public or
Private
Phone
Voice Mail
System
Dials Voice Mailbox
Leaves Message
Dials Voice Mailbox
Retrieves Message

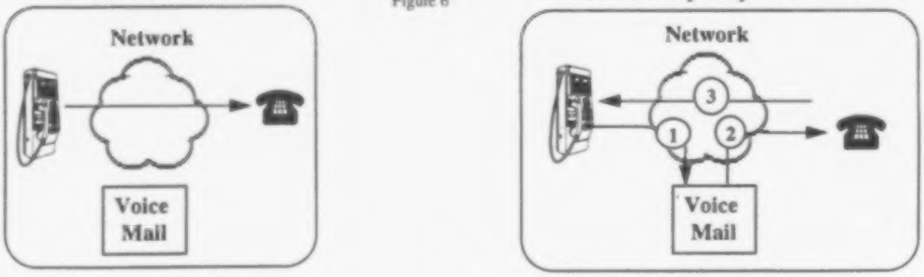
Figure 5

Public Phone Locations	Initial Services	Payment Options
Apartment House	Personal Voice Messages	Coins
Market, Shops	Broadcast Messages	Tokens
Streets	Community Information	Prepaid Cards

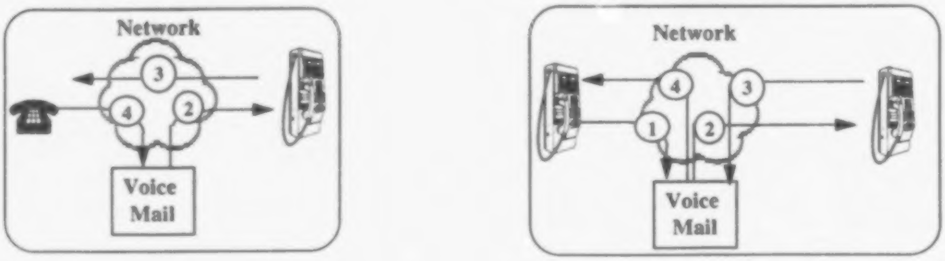
Scenarios

Figure 6

Called Party Available *Called Party Busy/No Answer*


Network
Voice
Mail
Network
3
1
2
Voice
Mail

Called Party has Voice Mailbox *Both Parties have Voice Mailboxes*


Network
3
4
2
Voice
Mail
Network
4
3
1
2
Voice
Mail

political need to address large numbers of unserved residences (perhaps voters) is also met. Figure 6 shows several calling scenarios.

While this plan changes the focus of the allocation of scarce investment monies, it also addresses the shortages of adequate trained staff in that it provides national services in a far more centralized way than traditional planning and construction would have required.

5.0 Key Public Phone Requirements

Because of the importance of the public phones to the successful implementation of this plan, our plan entails both modern, microprocessor controlled phones and a centralized management center and computer. It is necessary that certain key features be included both in the phones themselves, and in the central management system..

The first requirement for the phones, and perhaps the most important, is for ease of use. This means the phones must incorporate a human interface that is flexible, that assists users with both visual and voice prompting (in the appropriate language), and that is "discoverable" in that a user unfamiliar with the phone can readily "figure it out," even if he is not well educated.

The public phones must provide a variety of payment options, including the acceptance of "smart cards." (See Figure 7.) These can aid ease of use, not only by simplifying payment, but also by supplying intelligence and information, for example, to cause the phone to automatically make a connection with the voice mail system when the card is inserted.

Naturally the phones need a rugged construction that is suitable for installation in varying climates and environmental conditions, coupled with self-diagnostic and alarm capabilities to insure the phone really delivers on the promise of "high availability."

In addition to being compatible with all types of existing network infrastructures and switching systems (not just those of a single manufacturer), the phones need to have sufficient local intelligence to handle most functions themselves, including antifraud features. (These may include coin control functions, if coins or tokens will be used, both to guard against theft and to simplify handling, and such features as coin accounting, coin alarms, and electronic housing and coin box locks.) The phones should also readily handle outages of the facilities to the centralized network control center computer.

Last, but hardly unimportant, the phones must have simplified installation procedures to reduce the need for skilled labor on the part of the local telephone administration. The phone itself should contain installation menus, including verification of successful installation and logging of the time spent accomplishing the installation.

The centralized management system provides the facilities for the day-to-day successful operation of all of the phones, regardless of their number or location. The system must operate 24 hours a day, 365 days per year, and have the capacity to quickly handle the transactions from multiple phones at once. For an economical installation, the system must be modularly expandable, so that the initial system handling only a few hundred phones can readily be expanded while in operation to accommodate massive growth in the installed phones. (Although geographies and demographic variations make generalizations difficult, experience in other countries suggests that around 5000 public phones per million unserved population would be a reasonable estimate for budgetary purposes.)

6.0 User's Perspective

From a residential user's perspective, modern public phones would be found nearby, on streets, in apartment building and shops, etc. These phones would have two uses, the first being the obvious; allowing the citizen to place calls to any other telephone subscriber worldwide.

(There are numerous options as to how such calls could be paid for. Of course local coins can be accepted, as well as credit cards, either conventional types such as Visa, or the telephone company issued type. Some administrations are also considering the idea of a debit card issued by the telephone administration or postal authority. Such a card could also be associated with identification or a social security-type account, and could provide the holder with certain amount of usage "credit" each month along with health or other government sponsored benefits.)

The second, and initially perhaps more important, purpose for the numerous public phones is to provide READILY available access to the national voice mail service. While exchanging messages with others via a voice mail system is certainly not the same as a live telephone call, it is both CLOSE to it, and FAR BETTER than the alternative, under more conventional planning, of no communications at all for many years. With just a little exposure, users can readily learn how to create and send messages, and to listen to those left for them, either by other voice mail users, or

Smart Card Advantages

Figure 7

Smart Card
- Credit Card Size
- Microprocessor Based
- Environmentally Sturdy
- Secure, Personalized

Payment

Prepaid, limited free
Avoids coins
- collection
- handling
- theft
- vandalism
- reliability

Rechargeable
Controllable
Fraud resistant

Revenue Generation

More, longer calls
Advertisements
Float
- prepaid
- lost card
- collector item
- tourists

Service Enhancement

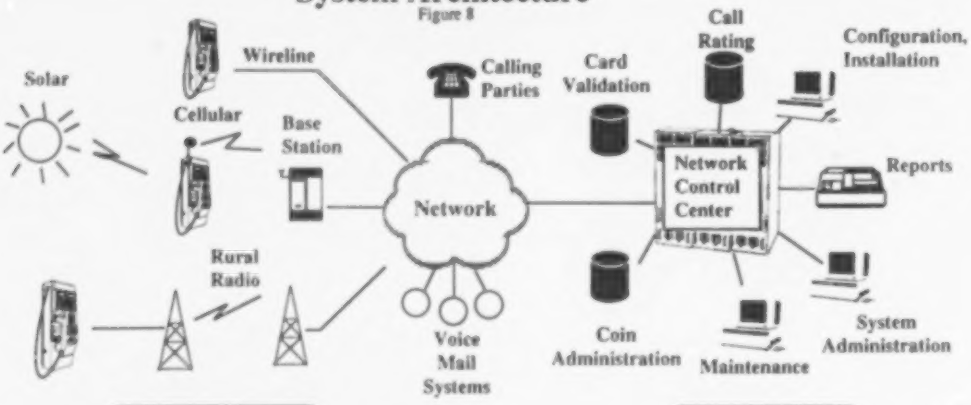
Auto mailbox call
Information storage
- identity
- personal (health)
- access control

Security (PIN)
Other uses (transit)

High Tech ⇨ **Simplified use**
Value added
Low cost

System Architecture

Figure 8


Solar
Wireline
Cellular
Base Station
Rural Radio
Calling Parties
Network
Voice Mail Systems
Card Validation
Call Rating
Configuration, Installation
Network Control Center
Reports
Coin Administration
Maintenance
System Administration

Ease to use/install
Multilanguage
Single Button Commands
Rugged
Network Compatible
Local Intelligence
Fraud Control
Smart Card/Coin

High Capacity
Central Control
Fast Response
High Reliability
Powerful Antifraud
Expandable

by regular telephone subscribers. And with the distribution list and broadcast facilities of the voice mail system, local government and organization leaders can quickly send announcements or news to dozens, hundreds, or thousands of users simultaneously.

Fewer switches and exchanges in the network means the relatively few trained operations and maintenance staff are not spread as thinly, and higher service levels result. The voice mail system is centralized as well, with one system able to handle hundreds of thousands of users. Figure 8 shows the overall architecture of the proposed system, and Figure 9 demonstrates the relative cost advantages it brings.

Countries develop over time, and so the question of migration naturally comes to mind with any architecture. As noted on Figure 10, the proposed system has no "throw a way" components, and evolves easily as the telecom network matures.

7.0 Value Added Services

And what about the Value Added Services for spurring business growth? One of the best examples is Electronic Data Interchange (EDI) which can benefit any business but is especially valuable to companies involved in international trade. Korea and Taiwan are both examples of countries that recently launched new national public network EDI services; not surprisingly, exports play a large role in both of their economies.

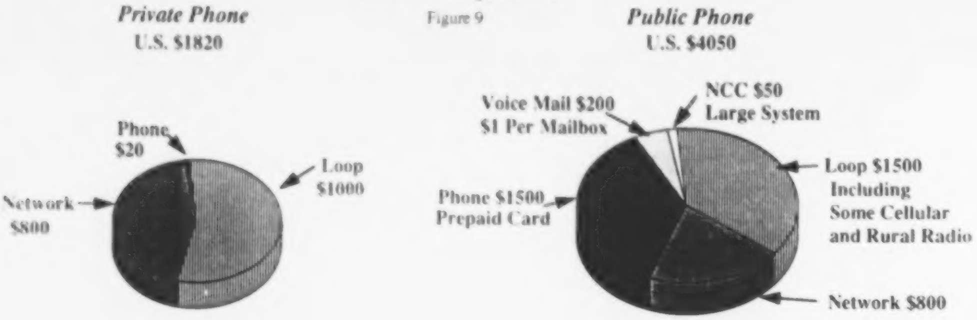
8.0 Conclusions

At Asia Telecom '93 last May in Singapore, Professor Gert Lorenz of the University of Technics in Munich, Germany, put it this way: "It is clear that telecommunications are an absolutely critical component in the successful operation of industrial, commercial, and business activities of every kind, and that corporate competitiveness is increasingly a function of telecommunication assets and exploitation. But perhaps of even greater importance, it also constitutes a potent force for social cohesion, improvement of lifestyles, and equality of opportunity in a country."

The conclusions are clear: everyone benefits from better telecommunications services, resources are scarce and are likely to continue to be so, and the key to progress is thus the EFFECTIVENESS with which these resources are used. The authors quite logically might be expected to recommend the traditional approach to telecommunications planning, from their both having worked in the telecommunications industry for several decades. But other than hope that increased funding levels and training somehow appear, we proposed taking a more imaginative approach, one which we believe can achieve, before the end of this decade, the essential goals set forth in the original Maitland report. (See Figure 11 for a summary.)

Cost Comparison

Figure 9



5 Person Household

$360 Per Person

200 Person Group} 50 lines/100 people
1% lines are public

$20 Per Person

A public phone with voice mail can be
20 times as cost effective as a private phone

Plus...... Higher revenue potential, less need for skilled labor (Maintenance, Installation)

Reusable Investment

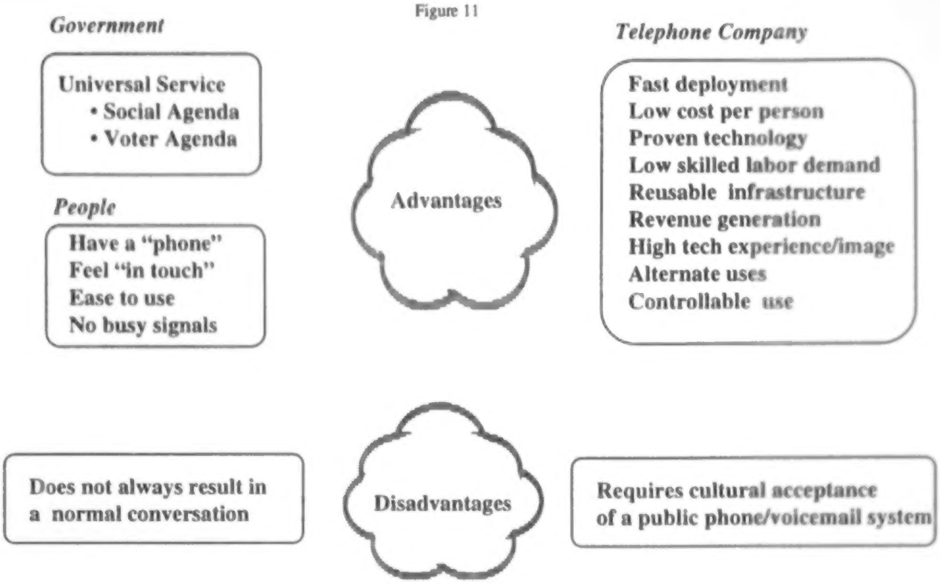
Figure 10

Public phone/voicemail investment can migrate smoothly from a "developing" to a "mature" telecom environment, without stranded investment, by moving to conventional uses and acquiring new services

	Mature Uses	New Services
Public Phone	Access for people away from home or office	Information terminal, credit card payment, transaction terminal, data port
Voicemail	Answering machine • Household • Businesses • Time Zone Buffer	Information Access: Community announcements Sports, weather, horoscope shopping, entertainment health, how to, ...

Summary

Figure 11



Government

Universal Service
- Social Agenda
- Voter Agenda

People

Have a "phone"
Feel "in touch"
Ease to use
No busy signals

Advantages

Telephone Company

Fast deployment
Low cost per person
Proven technology
Low skilled labor demand
Reusable infrastructure
Revenue generation
High tech experience/image
Alternate uses
Controllable use

Does not always result in a normal conversation

Disadvantages

Requires cultural acceptance of a public phone/voicemail system

DRIVERS AND INHIBITORS IN THE APPLICATION OF COMMUNICATION AND INFORMATION TECHNOLOGY IN AUSTRALIA AND FIVE ASIAN COUNTRIES

By

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ABSTRACT

The ongoing multi-billion-dollar worldwide investment in communication and information technology (CIT) has yet to yield full dividends in terms of increased productivity in the workplace, equitable distribution of knowledge among all the people, and enhanced quality of life. In this paper, we identify and discuss some of the factors that drive or inhibit the application of CIT in any country. We suggest that the time is ripe for an integrated research program to achieve better understanding of these and related factors. We conclude that the three essential ingredients of such a research program are: a remodelling of the information industry with a focus on the demand side, establishing appropriate CIT productivity indicators, and bringing together some of the fragmented strands of CIT related research. We propose that the implementation of such research in a number of countries that are at different stages in the development of their economies, and that represent a mixture of Asian and Western worldviews, wil raise the key institutional, cultural and developmental issues to light and yield insights useful in regional and national planning. We suggest that the regional neighbours Australia, Hong Kong, Indonesia, Malaysia, Singapore and Thailand as ideal candidates for study.

INTRODUCTION

Economic growth, productivity improvement, competitive advantage, and equitable distribution of knowledge will not be achieved merely by the application of more and/or better communication and information technology (CIT). Optimum outcomes require better understanding and management of the context in which the technology is being applied. In particular, we need to know more about the factors involved in restructuring the information industry (the computing, telecommunications, broadcasting and electronic publishing sectors), the performance of individual sectors, and the growing interdependence among them.

We also need a clearer understanding of the role of the State in regulating this mega-industry, and how the interpretation of this role may be influenced by a range of variables, e.g., a nation's form of government, its culture and values, and the extent to which public debate of such issues is encouraged, as well as its work-force composition and skills base, its geographical location, financial and economic institutions, market structures, trade policies, alliances, etc. Further, the influence on government policy making of such international bodies as the International Telecommunications Union (ITU), the International Organisation for Standards (ISO) and the World Intellectual Property Organisation (WIPO) must be taken into account. In other words, there is a need for a fully integrated approach to understanding if we are to be successful in managing the multi-dimensional change that flows on from the application of communication and information technology.

We believe that the situation is ripe for a comprehensive research project in a group of prototypical countries, i.e., Australia - a large country with a mature market economy, a high penetration of CIT, and a telecommunications sector that matches world best practice; Hong Kong and Singapore - two city states with newly developed economies and special plans to use CIT for strategic advantage; and Indonesia, Malaysia and Thailand - three large countries with developing economies but uneven penetration of CIT and an urgent need for large-scale infrastructural investment before services can be fully developed. These countries also represent a variety of government structures and a mixture of Asian and Western worldviews, and thus an opportunity to raise the key institutional, cultural and developmental issues.

An integrated study of the information industry in such a diverse group of countries, using the same criteria and methods, would yield data for more accurate comparisons among the countries. Such research would also indicate the relative importance of forces driving or inhibiting CIT application at national and regional levels. It would help to identify core problems, needs and strengths, as well as individual country differences, and would be useful in guiding regional planning. And we believe the involvement of Asian colleagues as co-investigators would enhance the credibility of such research.

In this paper, we comment on a sample of drivers and inhibitors in the uptake of CIT, in an effort to substantiate the need for such a study. We present a non-exhaustive list of the factors acting as drivers and inhibitors which require further research and, above all, coherent, integrated treatment. Finally we identify the three key elements for an integrated research project. Our aim is to map the contours of a major research project, and to take the first step towards a feasibility study as a precursor to that project.

A SELECTION OF DRIVERS AND INHIBITORS

Factors driving the application of CIT are much easier to identify than those that may be inhibiting it. In view of the relentless industry push for uptake of its products and services, drivers will also be more familiar to most readers. And yet there are many shades of grey. What is a driver in one context may be an inhibitor in another. Below, we identify some of the major factors in a sequence that shades from drivers to inhibitors.

Technology "Push"

The extraordinarily rapid pace at which new developments are occurring in digital electronic technology, coupled with constant improvement of the cost/functionality of computers and their networks, entices customers to "hedge their bets" by coming on board for fear their businesses will be left with obsolete infrastructure and processes. Once on board, they become enmeshed in a constant web of upgrades, running to keep up for fear of being unable to grasp the new methods when the come along, and unable to reap the rewards should they arise.

The Forces of Sectoral Restructuring

In a recent provocative article, The Economist points to a further tension driving technological development, i.e., the race for supremacy between the computing, telecommunications and television paradigms. The article goes so far as to predict that "The computer paradigm will prevail. Just as the 1980s brought the collapse of the centralised scheme of a few thousand mainframes and millions of dumb terminals, the 1990s will see the collapse of similar structures in television and telephony.... end-to-end digital systems will bring something quite different, and a true paradigm shift." [*The Economist*, 1993.] Users are caught up in the forces of this sectoral restructuring.

Marketing

Fierce competition for world markets, together with the multinational nature of large CIT firms, tend to lead to central design and control of marketing and sales strategies. This can result in a common marketing approach that takes little account of economic or cultural differences in varied national markets, and leads to patchy applicability - being a driver in certain contexts and an inhibitor in others.

The Integration of Social and Technical Systems

Given the technical nature of the products and services in question, many lay customers are at a disadvantage in dealing with high-powered sales teams or consultants. While this can be the case in all countries, the problem is aggravated in countries with underdeveloped or developing economies. We believe that efforts need to be directed towards better education and advice for customers in the selection and implementation of technological systems appropriate to their needs, in order to balance the intensity of the marketing effort. One foundation for this might be a much wider appreciation of the factors involved in the integration of socio-cultural and technical systems - following the tradition of the socio-technical systems analysis and design literature in management / organisation theory, post Emery and Trist [1960].

Customer Focus / New Forms of Work Organisation

The emerging global market place is presenting enterprises in all industries with new challenges. The age of relatively stable, high volume routine production is over. Increasingly the demand in the new market environment is for flexibility, innovation and responsiveness to customer needs. These demands have fundamentally changed economies of scale. They are, moreover, centrally addressed by CIT. Indeed the drive for CIT application, and the ability, and thereby the demand, to be flexible and responsive are intricately inter-related. [Valovic, 1992.] A greater understanding and appreciation of the inter-relationship between new market demands, new forms of work organisation and the application of CIT is required.

As Albert Bressand has pointed out: "Whether in electronic or in traditional form, information presents a major challenge to the traditional economic concept of 'product' and 'transaction.' Indeed, more is at stake in the move toward the widely mentioned 'information economy' than the inclusion of an ever more powerful information technology in a traditional industrial context." [Bressand, 1990, p.7.]

Transaction Costs

One of the factors in structuring industries is transaction costs. CIT networks are capable of fundamentally changing the costs associated with many forms of transaction, and, inter-relatedly, transaction relationships and structures. EDI (Electronic Document Interchange) is a prime example of the way that CIT networks can transform economic relations and, thereby, industry structures. A far greater understanding and appreciation of this inter-relationship is needed.

New systems for information processing and communication, such as EDI, mean that if a firm is to do business in a certain market or industry it must install technology that enables it to communicate with customers and suppliers already using these systems. While advances like EDI are to be welcomed for developed and developing countries alike, the Chief Executive of DACOM (Korea) has cautioned that: "...the countries are not all the same... because EDI... is closely related to service industries... if utilization of the network is widespread, it makes [it] easier to penetrate into the service market of developing countries by developed countries. In the circumstances, USA, Canada, Australia, New Zealand, Japan, Singapore, Hong Kong, etc., are emphasizing the earlier implementation of EDI, whereas other countries which do not have capability are rather passive in this regard." [Shin Yun-sik, 1993, p.1060.]

Government Practices

National governments can act as drivers of communication and information technology implementation by way of government requirements. For instance, United States census data are becoming available only in electronic form, which means that anyone wishing to use these data for research, marketing or other purposes must have electronic equipment to store and process them. Similarly, government requirements for electronic filing of data or information by businesses or individuals can impose system conditions on the filers. As consumers of CIT, governments can influence such things as adherence to standards, which can fundamentally change the cost:benefit of CIT applications for all users.

The degree to which governments consciously advance the implementation of CIT needs to be assessed in a variety of countries, as well as the unintended and possibly negative consequences of government requirements.

Understanding the Nature of Network Technologies

CIT applications are, commonly, network applications. The specific features of network technologies need greater understanding and appreciation than is yet the case. Network technologies exhibit specific features, such as network externalities. Without an understanding of the existence or extent of network externalities inherent in a particular CIT service, striking the appropriate level of government intervention or establishing a suitable pricing structure (connect versus usage pricing, etc.) will be difficult. And yet both are key determinants of adoption / use. [Guerin-Calvert & Wildman, 1991.]

Changing Workforce Expectations

Changing levels of computer literacy and expectations among the newer generation of workers make it almost imperative that they are provided with a computerised work environment. But these levels of computer literacy vary considerably from country to country and research into the strength of this driver / inhibitor in countries at different levels of economic development would provide information of value in getting a better match between education and industry development needs.

Outdated Policy Frameworks

Economic planning in most nations recognises the potential of communication and information technology (CIT), not just as a growth industry in itself, but as a generic technology that facilitates many other forms of development. As Sir Donald Maitland said, "The dual role of telecommunications as a sector of economic activity in its own right and as a means of transport for other economic activities has been recognized in the Uruguay Round of trade negotiations. If all goes well, the common ground on this subject between industrialized and developing countries will be enshrined in a Telecommunications Annex to the General Agreement on Trade in Services." [Maitland, 1992, p.16.] Governments the world over are anxious to create financial climates, organisational structures and regulatory regimes that facilitate the highest return on public and private investment in CIT infrastructure, manufacturing, software and services, so as to give their own nation a comparative advantage in highly competitive global markets.

But government policy and regulation are, for the most part, trapped in an outdated view of industry, one based on a system of classification that is now as much a barrier to analysis as a foundation for it; a system wherein primary production, agriculture, forestry and mining fed into secondary production, essentially manufacturing, which in turn supported a range of tertiary or service activities. Within this primary-manufacturing-services framework, a further level of industry classification, centred on the end product, provided the basis for industry analysis. Increasingly, however, this traditional view hides more than it reveals.

The absence of a comprehensive policy framework is one of the more powerful factors inhibiting cost-effective application of communication and information technology in any country. Analyses of white-collar productivity, CIT performance indicators, or carriage-and-content regulation suggest that the potential of CIT to contribute to economic and social life will not be fully realised until we can achieve an holistic view and manage industry policy, regulation, trade and other matters as if convergence really meant something. Fine-tuning regulation and policy around an individual sector of the information industry - be it software, telecommunications, broadcasting or whatever - may be constructive, but it is unlikely to be optimal.

Failure to Distinguish between Extensive and Intensive Network Development

One important factor influencing the restructuring of the information industry is the base level of development of the information infrastructure. In countries where a basic infrastructure exists, e.g., Australia, Hong Kong and Singapore, the focus is on its development for more intensive use through new services. In countries where the first priority is to build the basic infrastructure, e.g., Indonesia, Malaysia and Thailand, the focus is on extensive growth. Extensive and intensive network development require different strategies and different structures, and the transition from the extensive to the intensive network development phases requires special arrangements.

Ben Petrazzini [1993] has examined some of the issues relating to national strategies in telecommunications and their relation to politics in four countries, including Malaysia and Thailand. Using an approach like that of Petrazzini, it is possible to analyse the link between the political structure of a country and its resulting regulatory framework, and to assess the extent to which it serves to hinder or promote the successful application of CIT. However, there are influences on national strategy, relating to the distinction between extensive versus intensive network development, above and beyond those identified by Petrazzini.

Extensive Growth Factors

Where extensive growth is the focus, the basic requirement is for a national network development strategy to cover infrastructure growth, spectrum planning and management, satellite and VSAT communications, and the evolution of fixed and mobile networks. Demand is for the basic network equipment and operation, and the over-arching need is for capital to finance construction. [Maitland Commission, 1984.] The tendency, given the financial position and level of manufacturing development in the countries where extensive network development is the focus, is to seek capital injections. This includes development loans and, often, carrier privatisation - usually to foreign capital interests.

The need for effective deployment may require some organisational reform of the public and/or private sector players, but this is not necessarily the case. Regulation in the extensive network development phase will likely focus on ownership. Extensive network development does not require competition.

Industry policy can fit with extensive network development if it focuses on bringing in the basic manufacturing and/or assembly necessary to underpin it. Communications equipment manufacturers will be encouraged to locate manufacturing facilities within the country, to aid balance of trade and ease foreign currency demands. Manufacturing will be concentrated on the equipment needed for extensive growth. It need not be the very latest or most complex technology. It will likely focus on basic switching and basic customer premises equipment manufacturing.

Intensive Growth Factors

Where *intensive network development is the focus*, the major requirement is for service innovation. In this context, the network equipment requirements will be for leading edge technology and there will be a far greater emphasis on intelligent CPE (customer premises equipment). Service innovation will be driven by the demands of leading customers and by competition among suppliers. Hence, market liberalisation or competition among carriers will be a central concern.

The focus on leading customers is likely to mean far greater emphasis on government as a user and/or on the location of transnational corporations (TNCs) and linkages into global networks - hubbing, etc. Regulation in the context of intensive network development will need to focus on competition. The regulatory challenge will be to cope with the rapid development of new services and new ways to deliver content, especially in telemedia and multimedia formats. Balancing social concerns such as content regulation and privacy protection with the liberalisation of services delivery will be a major dilemma.

Industry policy can fit with the intensive network development phase if it focuses on the basic requirements of bringing in leading customers and moving towards state-of-the-art technology. Rather than basic manufacturing and assembly, leading edge R&D and manufacturing will be central. Indigenous participation depends upon genuine, rapid technology transfer and/or the focused promotion of indigenous technology.

In plotting the distinct dimensions of liberalisation or competition, on the one hand, and privatisation and foreign ownership, on the other, the fundamental need for intensive or extensive network development is critical. However, the intensive network development strategy soon leads to the need - or at least the desire - to deploy a broadband national network. This re-elevates infrastructure investment in the list of priorities. In such circumstances, one would expect to see a shift in national strategy back towards privatisation (capital) and away from competition *per se* - another swing of the privatisation-liberalisation pendulum.

Lack of Synchronisation between National and Corporate Structures

Network extension, and the underlying problematic of capital to finance it, demands the establishment and management of relations between nations and international agencies for aid-related development. Operational and management skills may also be required. BOT (Build-Operate-Transfer) relations encapsulate the rationale, and getting the T(Transfer) of both tangibles and intangibles to occur is the key. Reliance on market forces alone is unlikely to do it. An incentive structure that encourages skills and technology transfer, and creates the market space for the development of an indigenous industry based on indigenous capital and indigenous skills, is also necessary.

The intensive development of the network, and the underlying problematic of innovation, demands the establishment and maintenance of competitive, innovative relations. The need is for the latest technology, in the sense of both hardware and techniques, and the motive force of pull-through from leading edge users implies a strong linking to international supplier and consumer markets. For countries other than the U.S., Japan and the leading European nations, this requires the management of global participation in commerce, research, and education. Incentive structures fostering skills and technology transfer will need to be replaced or supplemented by incentive structures fostering integration into global production and marketing structures, education and skills development, research and innovation, etc.

Regulatory structures during extension will, similarly, focus on financing and building. Foreign ownership and participation will be more acceptable, and the gains to be got from allowing capital to reap return on investment over a period will likely outweigh concerns about pricing and innovation. Monopoly is more likely to be tolerated. During the intensification phase, far greater focus being on competition, regulation will be of competition: trade practices, pricing, access for competitors, etc. Monopoly will not be tolerated.

Corporations working to change national and international regulations and structures to which they are subject, become instigators of multifaceted restructuring. Ownership and control are the most fundamental restructuring criteria, but they are by no means the only ones. To repeat, where extensive network development is the major challenge, foreign ownership and monopoly of the carriage sector may be accepted in pursuit of the necessary capital and economies of scale. Where intensive network development is the focus, competition and innovation will demand the breaking down of private and/or public monopolies.

As a possible trade-off between economies of scale and economies of scope, cross-media ownership, the blurring of the carriage-content distinction, and vertical integration among the sectors of the information industry, are likely outcomes. Increased globalisation (the extension and integration of international activities) is another likely strategy to compensate for national limitations to economies of scope.

A further challenge for both government and corporate structures, and the balance between market and government intervention, is the management of some of the characteristics of information and information technologies. Value-Added Network services (VANs) are often one of the first markets opened to competition, and yet some intervention may be necessary. Some network services are subject to the inherent market failure of network externalities, others are not. Successful establishment of those services that are subject to network externalities cannot be left to market forces alone; intervention in market structuring and/or pricing regimes will be necessary. [Refer to the section 'Understanding the Nature of Network Technologies,' above].

Fuzzy Links between Commodification and Communication of Information

At the most general level, the information industry intersects two dimensions of corporate strategy: the commodification of information and the increasing use of and dependence on the communication of information as a part of doing business. Tessa Morris-Suzuki [1986] noted that the shift from making material goods towards the commodity production of knowledge is an essential feature of recent economic development. The information industry is at the very heart of this commodification process. It is a process that reaches well beyond broadcasting and publishing, the sectors most directly concerned with content.

There is a movement towards the commodification of information about the communication of information. Increasingly, information traces themselves become information and as significant business and leisure information services are being made available via networked communications, the value of and potential for the commodification of such information increases. Hence, there is growing pressure for the traditional communications sector to be opened up for exploitation by wider capital interests.

Large users, particularly transnational corporations, have become more and more involved in decisions about communications industry structure, ownership, pricing, policies, network development, and relationships with the State. In a recent contribution to a collection of Essays Honoring Dallas W. Smythe, Vincent Mosco [1993, p.137.] cites such North American examples as U.S. manufacturers pressing to keep computer communications out of the regulated sphere, and U.S. bankers and others arguing for preferential business rates.

Corporate strategies, then, centre around access to, control of, and participation in communications carriage and the generation of content through the commodification of information. They involve managing this access in the context of transnational networks, and trading the location of activities like manufacturing for participation at the national level.

WHAT CAN WE DO ?

What are the key elements of an integrated research project? We suggest that such a research project must involve three things:

- A remodelling of the information industry, taking account of today's market realities;
- A rethinking of productivity criteria and measures; and
- An attempt to bring together the major existing but fragmented strands of CIT applications research.

A Remodelling of the Information Industry

There has been an over-emphasis on the supply-side of the information industry. The implications for competition of the fact that the same enhanced information-processing functions can now be provided equally well either by the computing sector (via computers and intelligent terminals) or the telecommunications sector (via transmission links and switches) are not yet properly understood [Jonscher, 1986]. Nor is the increased power of selection in the hands of the customer fully appreciated. Surely now, more than ever, there is a need for demand-side (customer-driven) maps and models of the information industry.

Mansfield and Joseph [1992] have surveyed the earlier approaches to mapping and modelling the industry, with particular reference to those of the Harvard Project in Information Resources Policy [McLaughlin and Birinyi, 1984], the Information Industry Association [IIA, 1991], the Organisation for Economic Cooperation and Development [OECD, 1991]; and Nippon Telegraph and Telephone [NTT, 1990]. All of these approaches treat the information industry as a single unit covering computing, tele-communications, broadcasting and publishing. But while each of the resulting maps or models admirably meets the purpose for which it was specifically designed, all of them take a supply-side view, allocating products and services among the various sectors.

In an unpublished report for Telecom Australia, "New Roles for Telecommunications Organisations Within the Broader Information Industry" [1993], Mansfield has taken a new approach to mapping the industry. It is based on the premise that since industry developments are now being geared toward providing consumers with more choice among alternative methods of achieving the same objectives, it makes sense to look at the industry from the point of view of the information functions that customers need to perform and align sample industry offerings within each functional category. This approach is intended to highlight the substitutability of products and/or services and hence the degree of choice now in the hands of the customer. We believe that further development of this approach, based on an analysis of the sectors in the countries suggested for study, would further our understanding of the extent of competition among the sectors.

Productivity Criteria and Measuring CIT Productivity Improvements

One of the most puzzling issues in technology policy analysis has been "... the seeming contradiction between the perception that technical change has accelerated in the recent decade and the observed fact that productivity growth has not recovered to its average post-World-War-II levels [Bell et al., 1991, p.7]. With the enormous investment in communication and information technologies (CIT) in recent years, there is an urgent need to address this issue in all of the countries in the suggested study. The application of CIT is more than just the adoption of new technological products or processes. There is a considerable element of "learning by doing," involving the close interaction of firms, markets and governments. Some countries are better than others at creating environments that promote the desired flow-on benefits.

But attempts to measure the technology-and-productivity link are fraught with difficulties. First, there is a lack of agreement on appropriate methods of measurement and a lack of consistency in the base statistical data available. The OECD has commenced its own investigation by compiling an extensive database of indicators covering both quantitative and qualitative aspects. The extent to which the OECD indicators and investigative methods would be applicable in non-OECD countries, such as the majority of those in the proposed study, is an important topic for research.

Second, there is an increasing awareness that organisational differences, between countries and firms, could be a significant factor in the technology-and-productivity relationship [Nelson, 1991]. Organisational differences can include such factors as a nation's financial and economic institutions, regulatory structures, skills base, university system, and training schemes for engineers and applied scientists. For example, the regulatory environment in a particular country is likely to determine the flexibility with which firms are able to respond to change and to exploit new market opportunities.

A far greater understanding of the complex of factors involved in assessing information productivity, indeed the very meaning that one could attach to the term information productivity, is a fundamental and urgent requirement.

Bringing Together the Major Strands of CIT Research

The non-exhaustive exploration of some of the major drivers and inhibitors in the application of CIT (above) points the way to some of the major strands of research that need to be brought together in a comprehensive and integrated project such as that outlined in this paper. These strands include:

(i) Analysis of the inter-relation of social and technical systems - CIT is not just a powerful tool, but can also be a fundamentally new way of thinking, of doing and of organising;

(ii) Further analysis of new forms of work organisation - the demand for flexibility and responsiveness is bringing enterprises closer to their customers and fundamentally changing the shape of the market and of competition;

(iii) Further exploration of transaction cost economics - CIT's facilitation of economic relations is capable of fundamentally restructuring economic relations, changing economies of scale and scope, radically shifting the balance viz-a-viz internal and external governance structures, and blurring the distinction between internal and external in the formation of new forms of competitive-cooperative relations;

(iv) Analysis of the nature of network technologies - the roll out of network services has, to date, displayed little appreciation of the impact of such features as network externalities on the institutional context and incentive structures in which that roll out takes place, or of various alternative pricing structures;

(v) Analysis of the reform of national institutional structures - especially relating to legal and regulatory structures; and

(vi) Further development of the work on political structures begun by Ben Petrazzini - linking it to an appreciation of the key phases in the development of networks.

A broad level synthesis of these strands of research is a necessary precursor to learning the lessons that each can contribute to an understanding of the factors involved in driving and/or inhibiting the application of CIT.

CONCLUSION

In conclusion we suggest that it is time to begin an integration of the disparate strands of CIT related research. *Inter alia*, this must include: an analysis of the inter-relation of social and technical systems, further analysis of new forms of work organisation, further exploration of transaction cost economics, an analysis of the nature of network technologies, an analysis of the reform of national institutional structures, and further development of the work on political structures begun by Ben Petrazzini.

We propose that that integration should be founded on a remodelling and reconceptualisation of the information industry: a remodelling based on the demand-side rather than the supply-side. And we suggest that a parallel focus on CIT related productivity indicators and measures provides both a mechanism for addressing, and the discipline for thinking about the key factors involved in driving and/or inhibiting the application of CIT.

In this paper we have begun to sketch out the terrain of an integrated research project focusing on drivers and inhibitors in the application of CIT in a diverse range of regional Asia-Pacific neighbour countries. We have attempted to demonstrate the importance of such a research project. We now seek the help and support of our colleagues, particularly those of our fellow researchers in Asia, to help in developing, refining and implementing it.

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STRATEGIES FOR FINANCING TELECOMMUNICATIONS INFRASTRUCTURE DEVELOPMENT IN THE PACIFIC RIM

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1. ABSTRACT

Private financing of telecommunications infrastructure development is playing an increasingly important role in the Asia Pacific region. This paper describes the primary strategies that have been employed in the Pacific Rim with illustrative country examples. The authors hope that this information will further help stimulate private sector investment in telecommunications infrastructure development.

2. INTRODUCTION

In 1984, the Independent Commission for World-Wide Telecommunications Development recommended a variety of methods for stimulating the expansion of telecommunications across the world. The Commission's goal was to narrow the gap in telephone service between industrialized and developing countries.(1)

Ten years later, telecommunications infrastructure development in the Pacific Rim, and financing of that development, remain critical issues for the region. Reflecting the magnitude of this challenge, the World Bank recently estimated that developing countries, including Asia/Pacific, would have to invest US $25-30 billion per annum to meet demand for basic telephone service by the year 2000.(2)

Beginning in the late 1980s, the pace of Asia/Pacific telecommunications development began to quicken. Many governments embarked on major privatization programs and regulatory reforms to encourage private sector investment. Today, as a result, there are numerous telecommunications infrastructure projects underway or proposed in the region.(3) These projects rely upon various strategies to attract new sources of capital, management and technology to the telecommunications sector. In each case, the strategic goal is to stimulate private participation and investment in order to finance the modernization and expansion of network facilities and services.

Recent financing activity falls into two broad categories: (1) sovereign borrowings, government guarantees and other forms of direct government involvement (e.g., Indonesia and the Philippines); and (2) various privatization strategies, including the sale of stock in a (fully or partially) privatized telecommunications company (e.g., Singapore, Philippines, Malaysia and Australia); and Build-Operate-Transfer (BOT) and similar arrangements (e.g., Thailand and Indonesia).

Several financing trends are clearly emerging in the region. First, private financing of infrastructure projects is playing a critical role and will continue to do so in the 1990s. Governments have recognized the advantages of greater private sector involvement, and are benefiting from general investor confidence in the region.(4) There has been strong private interest in the region's telecommunications sector. Singapore Telecom and the Philippine Long Distance Telephone Company have recently completed successful equity offerings. Predictions have been made that there will be 26 major public share offerings for telecommunications operators in the Asia Pacific region by the end of the decade, raising over US $40 billion.(5)

Second, while the trend is towards privatization, no one financing approach fits every country's needs and circumstances. Even within a country, more than one financing strategy may be employed. The Philippines, for example, is exploring a range of options including sovereign borrowings, equity placements, and revenue-sharing arrangements. The particular financing strategy ultimately depends upon the country's specific needs and relevant economic, political and social factors. For example, revenue-sharing, BOT and other concession arrangements have attracted particular interest in countries where privatization or regulatory changes are not an option.

The final trend is that financing activities by privately-owned telecommunications companies, including service providers and system operators, are playing an increasingly larger role in the region. The number of privately-financed wireless systems under development in the region, both terrestrial (e.g. cellular) and satellite, is particularly striking. This private activity offers great promise for expanding and modernizing telecommunications services, and, in some cases, leapfrogging stages of network development.(6)

3. SOVEREIGN BORROWINGS, GOVERNMENT GUARANTIES AND OTHER FORMS OF DIRECT GOVERNMENT INVOLVEMENT

3.1. Overview of Strategy.

The traditional approach to telecommunications infrastructure development has been through sovereign borrowings, typically involving an incumbent government-owned telecommunications company. In the developing world, the availability of credit for such borrowings depends upon a range of factors, including the overall creditworthiness of the country, currency exchange rates, and political stability. International and regional lending institutions, such as the World Bank and the Asian Development Bank, have played a major role through direct loans and loan guarantees.(7)

The World Bank is the largest multilateral source of telecommunications financing with US $1.8 billion lent in 1987-1991 for 23 stand-alone telecommunications investment projects worth US $9.2 billion in 21 countries.(8) Bank loans and credits typically finance 15-50% of total project cost, with the rest coming mainly from internally generated funds, supplier and export credits and aid, and government and other sources.

The World Bank Group, which includes the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA), is moving towards flexible and innovative ways of packaging the range of assistance options that it has at its disposal. These include the Bank's sector analysis capability, IFC's experience in raising equity and debt financing and MIGA's guarantees against non-commercial risks. An important joint role of these organizations is to put together risk reduction packages where needed to attract private investment in telecommunications.(9)

The Asian Development Bank has also played a significant role in telecom infrastructure financing, particularly in the Philippines, Indonesia and Singapore. In June 1993, for example, ADB approved a $195 million loan to Indonesia for telephone network expansion and consulting services to help the government implement deregulatory and structural reform policies.

The U.S. Export-Import Bank, and similar institutions in other industrialized countries, have also been active in the region. Exim Bank provides direct loans to foreign buyers of products or services produced in the United States. Credit, guarantee and insurance programs are also available to facilitate export financing, and minimize credit risks to the private sector. The U.S. Exim Bank, for example, has provided guarantees and direct loans for a variety of telecommunication products in Indonesia and the Philippines.

Recently, World Bank and ADB loans have been increasingly aimed at achieving structural changes in the telecommunications sector in conjunction with physical improvements. This approach is designed to encourage privatization of state enterprises and, in turn, the resulting benefits of increased investment, growth and efficiency.(10) As a result, the World Bank and ADB financing packages typically include technical assistance for regulatory and general telecommunications sector reforms. The lending may be tied to specific progress in restructuring state operations as commercial enterprises; ensuring competent management; limiting expansion into new telecommunication services and networks; and developing a policy and regulatory framework to promote competitive markets and private participation.

Increasingly, an issue for the World Bank and other public sector financial institutions is whether to lend to private telecommunications companies, including newly privatized state companies.(11) The World Bank's first loan to a private telecommunications company was the Philippine Long Distance Telephone Company in 1992. The U.S. Exim Bank is also examining the implications of lending to privatized companies rather than governments. This issue has been raised in connection with PT Satelit Palapa Indonesia (Satelindo), the new Indonesian satellite company which took over the satellite business from the state-run Telecom in January 1993. The legal and policy issues raised by such lending have not yet been fully addressed by these organizations.

As private sector involvement in infrastructure development increases, the IFC is likely to play a larger role in the region. The IFC is the world's largest source of financing for private enterprise in emerging economies. Project financing is offered through loans, equity investments and other financial instruments. It is able to tap additional financing from international commercial banks through loan syndications and securities underwriting. IFC is also willing, in appropriate cases, to take an equity position.

3.2. Specific Country Examples.

3.2.1. Indonesia.

In Indonesia, basic telecommunications services are provided by two state-owned monopoly companies: PT Telekomunikasi Indonesia (PT Telekom) provides domestic service; and PT Indosat provides international service. PT Industri Telekomunikasi (PT INTI) is a state-owned telecommunications equipment manufacturer.
Basic services include telephone, telex, telegram, and fax services. International basic services may also include international TV and teleconferencing, Intelsat Business Service and others.(12)

Indonesia has announced an ambitious development plan, which proposes to increase the total capacity of the telephone network by 5 million telephone lines by 1999.(13) Financing of new capital investment is generally derived from foreign loans and, increasingly, through revenue-sharing arrangements with the private sector as discussed below.

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The World Bank has two loans under implementation in Indonesia for telecommunications development: a 1990 loan for $350 million (Third Telecommunications Project), and a 1992 loan for $375 million (Fourth Telecommunications Project). These loans are for general physical improvement of the telecommunications network and institutional reform.

The 1992 loan covers sectoral reform and an investment program to improve telecommunications performance by promoting a more competitive and efficient institutional regime, as well as to help meet the growing demand for telecommunications services. Specific components of the project include: developing strategic options to promote competition and increase private sector participation; preparing and implementing an action plan to restructure and decentralize the sector's organization and improve its management; the provision of switching and cable networks to connect about 600,000 new telephone lines; and the rehabilitation and replacement of obsolete network facilities.

The total cost of the project, which is expected to be completed in 1998, is approximately $1.35 billion. The loan is repayable over 20 years, with five years of grace, at the World Bank's standard variable interest rate. The Government of Indonesia and Telekom are providing $546 million, and co-financing is being provided by the Federal Republic of Germany; France/Credit Lyonnais; Japan/Sumitomo Corporation; the Netherlands/ABN-Amro Bank; Spain; and the Exim Bank of the United States. The implementing agencies are Indonesia's Ministry of Tourism, Posts and Telecommunications, and Telekom.

Indonesia is also financing telecommunications infrastructure development under the Asian Development Bank's Second Telecommunications Project. This loan, approved in June 1993, provides $195 million for the physical expansion of facilities and sector reform. PT Telekom and the Ministry of Tourism, Posts and Telecommunications are the executing agencies for the project. ADB will finance 32% of the project, which covers telecommunications development between April 1993 and June 1998. Telekom will finance 54% of the project, and additional funding will be provided by Germany's Kreditanstalt fur Wiederaufbau and Japan's Exim Bank. PT Telekom recently issued an invitation for bids for the supply, delivery and installation of outside plant equipment, and plans to solicit bids for other equipment including microwave systems, public call offices, and rural telecommunications access equipment.(14)

ADB's first loan to the Indonesian telecommunications sector was approved in February 1992, and provided $185 million for improvement and expansion of physical facilities. The project was co-financed by the Japan ExIm Bank, the US ExIm Bank and Kreditanstalt fur Wiederaufbau.

The U.S. Exim Bank has provided funding and guarantees for telecommunications infrastructure development in Indonesia involving U.S. vendors. For example, in 1991 the Bank provided $60 million for a line expansion project involving AT&T. Exim Bank also funded the Palapa satellites built by Hughes.

3.2.2. **Philippines.**

The Philippine Long Distance Telephone Company (PLDT), the country's largest telephone operator, controls over 90% of the local and international telephone market. It operates a nationwide transmission network through which it provides toll services for its own consumers and for almost all of the nation's international telephone traffic. PLDT's network connects 65 exchanges owned and operated by other private operators, and 25 exchanges operated by various government agencies.

The World Bank has extended a number of loans to the Philippines, including a 1985 loan for technical assistance in improving the country's telecommunications infrastructure, and a $134 million loan in 1992 for technical and institutional assistance in connection with a telephone system expansion project. The 1992 loan, made to the Development Bank of the Philippines, was re-lent through a banking syndicate to PLDT and was the Bank's first loan to a private enterprise. The total cost of the expansion project is $288 million with PLDT providing the remaining $154 million in project financing. PLDT is the implementing agency.

The objectives of the Philippines telephone system expansion project are to increase telephone service and leased line facilities in PLDT service areas, with an emphasis on provincial development. Other goals are to improve the quality of PLDT services and to address deficiencies in sector management and regulation. The project includes provision of 133,000 lines of exchange and related equipment.

In addition to the World Bank financing, PLDT is pursuing other strategies. As discussed below, it recently concluded a successful offering of US $316 million in convertible preferred shares and is expected to seek funding of at least $200 million in 1994 in the international markets to finance its next phase of expansion. PLDT is also studying the feasibility of installing 600,000 lines on a modified Build-Operate-Transfer (BOT) basis.

4. VARIOUS PRIVATIZATION STRATEGIES

Privatization, in a broad sense, can be defined as any measure resulting in the transfer from the public to the private sector of ownership or control over assets or activities.(15) In the telecommunications sector, privatization typically involves restructuring state operations as commercial enterprises with increased financial and administrative autonomy from the government. Privatization facilitates and provides a structural framework for private sector

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investment, and leads to further investment in the privatized enterprise.

Privatization is a complex process which may require structural, economic and regulatory reforms. Among other things, privatization may require the country to build up the government's policy formulation and regulatory capabilities independently from the operating entities, and to develop a policy and regulatory framework to promote competitive markets and private participation.(16) Statutory changes are frequently necessary.

The transfer of ownership to the private sector may be accomplished through various mechanisms including the sale of shares to the public or to strategic investors usually through a bidding process, or may involve setting up state/private joint ventures. Privatization may include public offerings; negotiated sales or auctions; management buy-outs; sales to employees; and concessions (BOTs).

This section provides examples of specific mechanisms that have been employed in the Pacific Rim. These are: (1) sale of stock in a fully or partially privatized telecommunications company; and (2) BOT, concession and revenue-sharing arrangements. A review of these examples indicates that no one model exists. Rather, the privatization strategy depends upon, and reflects, a range of economic political and cultural factors.

4.1. Sale of Privatized Telecommunications Company

Transfer of ownership of a government-owned telecommunications company to the private sector has provided a significant source of infrastructure financing in the Pacific Rim. Typically, a phased approach to privatization has been utilized in the region.

One strategy, exemplified by Singapore and Malaysia, involves the first-stage conversion of a government-owned carrier into a public limited company, followed by a second-stage public stock offering. In Singapore and Malaysia, the government retained a controlling interest in the telecommunications company, and a relatively small portion of the capital stock was initially made available to the public. Thailand is reportedly considering a similar approach to privatization.

Australia illustrates a different privatization strategy. In Australia, a government-owned satellite company was privatized in 1992 through sale to a private sector joint venture, Optus, comprised of Australian and U.S. companies. This entity was authorized to compete as a second carrier with the government-owned telephone company for long-distance and international services, with a transition to full network competition planned in 1997. Although there has been discussion about privatizing Telstra, the government-owned telephone carrier, this does not appear likely to happen under the current government.

In contrast to other countries in the region, the Philippines Long Distance Telephone Company (PLDT) has been publicly held and listed since the 1950s. However, it provides an example of a successful post-privatization public offering.

4.1.1. Singapore

Historically, the Telecommunications Authority of Singapore (Telecom), a government-owned entity, had the exclusive privilege of operating and providing telecommunications services in Singapore. In 1992, Telecom was converted into a public limited corporation and will continue to hold monopolies in mobile telecommunication services and local/overseas phone services for the next four and 14 years, respectively.

In November 1993, Telecom floated 11% of its share capital, with a commitment to sell up to 25% over the next seven years to private investors. The Telecom offer, billed as the largest flotation so far in Southeast Asia, was managed by Goldman Sachs.(17) The offer was divided into three classes of shares with Group A and Group B shares reserved for Singapore citizens. Group A shares were sold with a 40% discount in the form of bonus shares over a period of six years. Group B shares were offered without discounts to Singaporeans. Group C were available to local and foreign investors on a tender basis. The Group C shares comprised half the float.

Trading in the shares has been reported as brisk, with shares selling at 150% over the base offer price. The trading price put Telecom's market capitalization at US $40 billion.(18)

4.1.2. Malaysia.

Prior to 1986, Jabatan Telekom Negara (JTM), the Telecommunication Department of Malaysia, was the monopoly government-owned telecommunications service operator. On December 9, 1986, a new public limited company, Syarikat Telekom Malaysia Berhad (Telekom Malaysia), received a 20-year license to run the country's telecommunications network. On January 1, 1987, the operating function of JTM was transferred to Telekom Malaysia. JTM was restructured into a regulatory government body.(19)

In line with the government's phased approach to privatization, the next step was to release share equity in Telekom Malaysia to private investors on the Kuala Lumpur Stock Exchange in 1990. Today, Telekom's single largest shareholder is the Malaysian government (the Minister of Finance Incorporated) which holds a 74.8% stake. The remainder of the company is owned by Malaysian and foreign investors.

Although the prospect of a second telecommunications network has been raised, recent reports are that Telekom Malaysia will remain the sole national network provider.(20) The government will encourage the private sector to invest in and operate other telecommunications services that can be interconnected, including cellular services.

4.1.3. Australia.

In late 1990, Australia announced a comprehensive plan for the liberalization of its telecommunications industry. The liberalization plan called for the staged introduction of privatization and competition -- from a single government-owned monopoly in 1991, to a full competition government-protected duopoly by 1992, to open competition by 1997.

Implementation of the plan is now under way. In 1991, Australia merged its domestic (Telecom) and international (OTC) public network operators into a new entity, which today is called Telstra. Also in 1991, the Government selected Optus Communications over at least one other private bidder to be the second licensed carrier. Optus is a joint venture with 51% ownership by an Australian consortium and 24.5% each by a U.S. company (Bell South) and a U.K. company (Cable & Wireless). Optus subsequently acquired AUSSAT, the government-owned satellite company through a tender process. (21)

Optus, provides long distance and international services and does not currently plan to enter the local call market.(22) Australia has also removed restrictions to third party resale.(23) Australia plans to end the government-protected, long distance/international network duopoly and begin open network competition in 1997.(24)

In late 1992, Australia licensed a third company -- now called Vodaphone Australian -- to provide cellular mobile telecommunications in competition with Telstra and Optus. Vodaphone Australian is 95% owned by Vodaphone Plc, a British company. As a condition of its license, Vodaphone Plc is required to reduce its shareholding to less than 50% by 2003, in order to increase Australian ownership.(25) Vodaphone is expected to begin operation in late 1993.

Australia faced two major issues in moving toward open competition. The first issue involved providing Optus sufficient time to become independent and a serious competitor. This was resolved by instituting pro-competitive safe-guards, including equal access and interconnection between the carriers.(26) Initially, Optus is leasing existing network capacity from Telstra for a substantial percentage of Optus' traffic with the expectation that Optus will bo largely independent by 1997.(27) Optus pays Telstra an interconnection charge for the leased capacity set by the government.

The second issue involved universal telephone service. Australia determined that it could continue to bear the cross-subsidy costs of providing universal service because of the competitiveness of its telecommunications industry and the high level of telephone ownership.(28) Thus, the government has required Telstra to continue providing standard telephone services and payphones within Australia. The costs of providing these services are being funded on a pro rata basis by Telstra, Optus and Vodaphone.(29)

Following Optus' entry, the price of long distance calls dropped 20% and is expected to drop 40% by 1997 and 60% by 2002.(30) Optus plans cumulative capital investment and other expenditures of approximately US $4 billion during 1992-1996.(31) In addition, Optus has committed to export US $500 million in goods and services by 2002.(32)

4.1.4. Philippines.

PLDT has been publicly-listed since the 1950s and thus does not present a recent privatization scenario. However, its experience does provide an example of a post-privatization equity offering and suggests the willingness of international markets to provide capital for privatized telecommunications companies in the region.

In 1992, PLDT raised US $316 million to help fund its expansion and modernization plan through an equity offering. The 1992 offering involved a private placement of PLDT convertible preference shares and global depositary shares. The issue was arranged by CS First Boston, and consisted of dollar-denominated global depositary receipts representing peso-denominated preference shares convertible into PLDT shares. This complex structure was necessary to avoid legal problems connected with the company share structure.

Half of the convertible preference shares were offered by private placement in the United States, with 36% of the offer allocated originally to the Asian market and 16% to Europe. The shares can be converted at the holder's option at a ratio of one ordinary share for every 1.735 convertible preference shares.(33)

4.2. Concessions, BOT and Revenue-Sharing Arrangements

In the search for new ways to finance and promote infrastructure projects, developing (and industrialized) countries have turned, in recent years, to various techniques of providing substantial non-recourse financing for major privately owned projects.

One of these techniques is "BOT", which designates a "build, own, and transfer" or a "build, operate and transfer" project.(34) The BOT approach was developed at the end of the 1970s as a way for countries with limited sovereign borrowing capacity to acquire needed infrastructure (typically in the power, electric and road construction sectors.) The project company in a BOT arrangement raises the bulk of the financing from commercial lenders, usually supported by export credit guarantee agencies, and from bilateral and multilateral financial institutions.(35)

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The BOT approach has a number of variations, all of which involve the establishment of a private sector project company as a vehicle for ownership, financing, construction, maintenance and operation of an infrastructure project for a certain period. Thereafter, ownership is usually transferred to the public sector. During the operation period, the project company charges prices sufficient to pay back the project debt and to provide a reasonable rate of return for its efforts.(36)

BOT projects are normally financed by a combination of debt and equity capital, on a non-recourse basis. That is, the lenders will have no financial recourse against either the project sponsors or the host government. Recourse is limited to the project company and its assets. The private sector bears a greater share of the risk because financing costs are normally paid from the project revenues. Generally, guarantees and safeguard undertakings by the host government will be necessary to obtain financing.

The BOT approach may be an attractive way for governments to limit commercial and operating risks, and to benefit from private sector efficiencies and expertise. BOT offers the potential for nations to attract international firms and debt and equity participants. It offers the promise of technology transfer and training to the host nation, and may offer the possibility of realizing a project that would not otherwise be built.(37)

The BOT approach offers one possible method for private financing of infrastructure projects, particularly where privatization of the whole sector is not an option. Perhaps for this reason, the BOT approach is currently attracting interest in the Pacific Rim. Thailand's experience with two BOT projects in the telecommunication sector is discussed below. Indonesia and the Philippines are also considering or implementing similar arrangements.

4.2.1 **Thailand.**

In Thailand, there are two state-owned telecommunications enterprises: the Telephone Organization of Thailand (TOT) and the Communications Authority of Thailand (CAT). CAT essentially provides all international telecommunications services, and TOT is the domestic carrier.

To finance infrastructure development, two BOT projects are currently underway in Thailand.

TelecomAsia, a consortium in which NYNEX, the U.S. operator, holds a 15 percent stake, has a BOT franchise to build and service two million lines in Bangkok as part of a telephone network renovation project.(38) A public share offer is planned for late November 1993 by TelecomAsia. The company plans to offer 10% of its shares in the initial public offer. TelecomAsia is owned 85% by the Charoen Pokphand Group and the rest by NYNEX. TelecomAsia has a 25-year phone concession, and is protected from private competition during the first five years of its concession.

The project cost, estimated at $2.5 billion, will be partially financed (37%) by concessionary loans, including $760 million in 10-year foreign supplier credits and $129 million of medium-term local supplier credits. Another 35% of project financing will come from equity, and the rest from revenue. A syndicate of private banks, under the leadership of Germany's Export and Import Bank, has provided a 25-year loan for $1.9 billion. The project is expected to provide a 37.2 percent profit margin during 1992-1997, easing to a 35.7 percent profit during 1998-2007.(39)

Thailand has also granted a BOT franchise to Thai Telephone and Telecommunication Co. (TT&T), a private company, to install one million lines in the provinces. TT&T is a consortium established by four major Thai companies, including Loxley (Bangkok) Ltd., a trading firm for telecommunications and computer-related equipment. Japan's Nippon Telegraph and Telephone holds a 20% interest in the consortium, and will be responsible for designing, constructing and operating the project. In July 1992, TOT awarded a concession to TT&T with a license period of 25 years, including five years for construction.(40)

4.2.2. **Indonesia.**

While sovereign borrowings continue to play a critical role in Indonesia, the country is increasingly turning to revenue-sharing or BOT-type arrangements with private-sector suppliers of telecommunications equipment in order to finance telecom development.

Under this approach, telephone lines and other services are installed by private companies. Revenue from operation of the lines is shared with PT Telekom before ownership is ultimately transferred to the government agency.(41) As of 1991, there were 13 private companies implementing six profit-sharing telephone projects with a total planned investment of US $1.4 billion.(42) Two of these projects involve foreign private investors (AT&T and NEC).

Under the revenue-sharing system, PT Telekom and private companies work together in constructing telephone infrastructure and facilities and in maintaining them. The operation of telephone facilities is also jointly handled by PT Telekom and the private investors. Profits are split in agreed-upon proportions.

PT Telekom has also used BOL, BOO and BOT arrangements to finance telephone line installation.

Another strategy used in Indonesia is to authorize private companies to provide basic services on behalf of the state-owned telecommunications companies, including cellular mobile services and paging services. Two private sector companies, PT Rajasa Hasanah Perkasa and PT Motorolain, have been authorized to provide cellular and paging services, respectively, on behalf of PT Telekom under a revenue-sharing arrangement.

4.2.3. Philippines

PLDT is currently seeking to modernize and expand the telecommunications system by installing 600,000 new lines on a modified BOT basis. Although funding has not yet been committed, feasibility studies are currently being carried out for this estimated US $3 billion project. The project developer is a group consisting of Cable & Wireless, Telstra International (Australia), Benpres (Philippines) and other investors.(43)

5. PRIVATE SECTOR INVESTMENT IN WIRELESS TECHNOLOGIES

In a paper of this scope, it is not possible to discuss every possible financing strategy or to account for the many variations within particular countries as a result of political, economic and cultural factors. However, in order to provide a more complete picture, mention is made here of other approaches that do not fit into any neat categorization. In this regard, it is important to emphasize the increasing role of private sector investment and competition in wireless technologies, including cellular telephone and satellites.

In contrast to the monopoly provision of basic telephone services, competition in cellular telephone and other wireless technologies is relatively flourishing. This competition has usually been accomplished by establishing an appropriate regulatory structure to allow for competition and licensing of competing service providers. Increased private sector participation in wireless technologies has attracted new sources of capital, management and technology into the telecommunications sector. The availability and diversity of telecommunications service has also been enhanced.

The Philippines has issued three nationwide cellular licensees, and may approve others. In addition to PLDT, private cellular mobile telephone operators are Express Telecommunications Company, Isla Communications Company and the Philippine Telephone Corp.

Malaysia has also issued multiple cellular licenses. A cellular license has been issued to Celcom, which with its parent company Technology Resources Industries (TRI) has recently launched other initiatives, including a $38 million investment in Rimsat, a satellite venture targeting the Asia-Pacific region, and a venture with Cambodia Post and Telecommunications to operate a satellite-based nationwide telecom distribution expansion. In addition, nationwide cellular licenses have also been issued to the Binariang Group and Mobikom, a consortium partially owned by Telekom. SkyTel Systems, a private company partially owned by Telekom, has been licensed to provide international paging service in Malaysia.

The Philippines has also introduced private competition in the international gateway service market. The country's regulatory agency plans to license two additional international gateway operators to compete with the two existing privately-owned international gateway operators: Eastern Telecommunications Philippines (40% owned by Cable & Wireless) and the locally-owned Philippine Global Communications Satellite Corp. Prospective bidders for the two new international gateway operator licenses include International Communications Corp. (40% owned by Telstra), Globe Telecom (30% owned by Singapore Telecom International), and Smart Information Technologies (39% owned by First Pacific of Hong Kong).

Private telecommunications companies, including cellular and satellite operators, are employing a variety of financing techniques to fund their activities in the Pacific Rim. To cite one recent example, PanAmSat successfully completed a public offering of debt securities in 1993. The net proceeds exceeded $400 million, and will be used to finance three new satellites for global broadcasting and business communications services. Two of these new satellites will cover the Asia Pacific region.

In addition, the process of licensing or authorizing additional operators may be used to exact infrastructure development commitments from the new licensees. This is a type of economic leveraging incentive that may be part of an overall development strategy. One example is the Philippines which announced in July 1993 that, under new licensing guidelines for international gateway operators, licensed operators could each be required to install as many as 400,000 new lines in rural areas.(44)

6. CONCLUSION

Ten years have elapsed since the 1984 Maitland Report. One of the most striking changes is the increased private sector investment in Asia/Pacific telecom development. Various strategies have been successfully used to finance telecommunications infrastructure development, and to encourage greater private sector involvement in infrastructure projects. While sovereign borrowings continue to play a major role in infrastructure development, this picture is changing. The World Bank and the Asian Development Bank are encouraging privatization and telecom sector reform efforts through their lending activities. In addition, the International Finance Corporation, which supports private sector participation in the telecommunications sector, is likely to play a more active role in the region by mobilizing equity and debt financing for private telecommunications projects.

Equity offerings of privatized telecommunications companies also promise to provide a significant source of capital for infrastructure development in the region during the 1990s. The public sale of Singapore Telecom shares and the private placement of PLDT convertible preferred shares were highly successful, and mobilized private capital for infrastructure projects. Thailand has indicated a desire to follow the Singapore model of phased privatization by 1995.

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Revenue-sharing and BOT arrangements are also providing an additional means of financing infrastructure development in the Pacific Rim. This approach allows for private participation where it may be difficult, for political or other reasons, to accomplish the structural and/or regulatory reforms needed to privatize a state-owned enterprise.

Finally, a number of countries in the Pacific Rim are successfully harnessing private financing by authorizing private sector competition in cellular and satellite services. This liberalization has attracted private investment in telecom development and increased the diversity and availability of services.

In conclusion, private investment in telecom infrastructure projects is emerging as a critical factor in the Asia Pacific region, and will continue to play an important role in future years. The desire for private capital is fueling regulatory and structural reforms in the region. Governments are moving toward greater private participation, including foreign investment, in infrastructure projects. The challenge for the region is to establish and maintain appropriate regulatory frameworks and a pro-competitive business environment in which private investment can flourish.

About the Authors

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(1) See Report of the Independent Commission for World-Wide Telecommunications Development, December 1984 (the "Maitland Report").

(2) Bjorn Wellenius, *et. al., Telecommunications, World Bank Experience and Strategy,* World Bank Discussion Papers No. 192 (December 1992) at 3 (hereinafter cited as *World Bank Experience.*) Telephone density in the Asia/Pacific region is still low by U.S. standards. More than three quarters of the region's households have no access to telephones. See Juliette Walker, "Asia-Pacific Telecommunications Market Holds Vast Potential," *Business Times,* May 17, 1993.

(3) For purposes of this paper, the term "infrastructure" is used in a broad sense to mean a country's domestic and international telephone and telecommunications networks.

(4) In 1992, the Asian economies outperformed the world economy in average growth. In comparison to the world economy growth rate of 1.8% in 1992, China's growth rate was 12.8%, Malaysia 8.7% and Thailand 7.5%. Asian countries attracted US $14 billion in net inflows of foreign direct investment. See Annual Report 1993, International Finance Corporation at 39.

(5) See "Thailand's TOT Gearing for Privatization by 1995," *Business Times,* July 6, 1993.

(6) There are a host of regulatory and legal issues raised by the telecommunications sector reforms now underway in the region and by the various financing strategies discussed here. Although a full discussion of the relevant issues is beyond the scope of this paper, it is important to note the importance of stable legal and regulatory frameworks for promoting private investment. In some instances, the pace of privatization in the region has outpaced the development of appropriate regulatory structures for promoting and managing a competitive environment.

(7) Indeed, until recently, the financing of telecommunications infrastructure projects in developing countries has largely been the exclusive domain of multilateral institutions like the World Bank. The high capital costs, long pay-backs and credit risks of these projects has meant that commercial bank financing may be unavailable or prohibitively expensive.

(8) *World Bank Experience* at 26.

(9) Id. at 16, 25 at n. 45.

(10) Id. at 5-8, 14-15.

(11) Id. at 16.

(12) *See generally APEC Telecommunications Working Group, The State Of Telecommunications Infrastructure And Regulatory Environment Of APEC Economies,* November 1991 at 85-88 (hereinafter "APEC").

(13) As of 1991, only 70% of the expressed demand for service was being satisfied, and only 40% of automatically dialed calls and 20% of long-distance direct-dialed calls were being successfully completed in Indonesia. IBRD Release No. 92/87 Asia.

(14) See *Pyramid Research Asia,* September 1993 at 11.

(15) Pierre Guislain, *Divestiture Of State Enterprises, An Overview Of The Legal Framework,* World Bank Technical Paper Number 186 (1992) (hereinafter cited as *Divestiture*). Privatization has also been defined as "a variety of techniques and

activities to get more involvement of the private sector in providing traditional government or public services." Irwin T. David, "Privatization: Steps to Successful Implementation," *The Privatization Review* (April, 1992).

(16) *Divestiture* at 14-15.

(17) Tony Shale, "Singapore: The Battle for Singapore Telecom," *Euromoney*, April 19, 1993. A consortium of six domestic banks (led by Development Bank of Singapore) was awarded co-arranger status on the domestic offering along with Morgan Grenfell Asia, a subsidiary of the U.K. merchant bank.

(18) "Singapore Telecom Debuts with a Bang," *Reuter Asia-pacific Business Report*, Nov. 1, 1993.

(19) Helen Nankani, *Techniques Of Privatization Of State-owned Enterprises*, World Bank Technical Paper No. 89 (1988) at 92-3.

(20) *See* Bahaman K'Zaman, "Malaysia: Telekom to Continue Enjoying Monopoly Status, Says Gov't," *Bus. Times (Malaysia)*, June 9, 1993.

(21) *Bureau Of Industry Economics, International Performance Indicators: Telecommunications*, Research Report 48 (1992) at 16, n. 22 [hereinafter *International Performance Indicators*]; and *Australia-Telecom Liberalization Progress, Market Reports, 1993 National Trade Data Bank*, September 15, 1993 [hereinafter *Telecom Liberalization Progress*].

(22) *Telecom Liberalization Progress*, supra note 26.

(23) Helen Meredith, "Pacific Star Invades Telstra Territory," *Australian Fin'l Rev.*, October 8, 1993 (available on Lexis).

(24) *International Performance Indicators*, supra note 26 at 16-17.

(25) Michelle Gilchrist, "Australia: Vodaphone Out to Prove It's Not No. 3," *Bus. Rev. Weekly*, April 16, 1993.

(26) M.J. Hutchinson, Paper Presented to World Bank/ITU/CTO/CTD Seminar on Implementing Reforms in the Telecommunications Sector: Lessons from Recent Experience, Washington, D.C., April 23-26, 1991 [hereinafter "Hutchinson"]. Australia's telecommunications regulatory body, AUSTEL, is facilitating the transition to open competition. AUSTEL ensures that Telstra does not derive an unfair market advantage from its dominant market position, and maintains a level playing field between the carriers in matters such as interconnection, network access, customer information, and billing practices.

(27) *International Performance Indicators*, supra note 26 at 16.

(28) *Hutchinson*, supra note 33.

(29) *International Performance Indicators*, supra note 26 at 17.

(30) *Telecom Liberalization Progress*, supra note 26.

(31) Id.

(32) Id.

(33) "Philippines: A Guide to Emerging Issuers - Philippine Long Distance Telephone Co.," *Euromoney Supplement*, Sept. 3, 1993; "Philippines: PLDT Convertible Deal Heads for New Increase-Philippine Long Distance Telephone Co.," *Euroweek*, October 23, 1992.

(34) Other variations include: BOOT (build, own, operate and transfer); BOO (build, own and operate); BRT (build, rent and transfer); BOOST (build, own, operate, subsidize and transfer.)

(35) See Mark Augenblick and B. Scott Custer, Jr., *The Build, Operate And Transfer ("BOT") Approach to Infrastructure Projects In Developing Countries*, WPS 498, World Bank Working Paper Series (August 1990).

(36) Id. at 9.

(37) For a detailed discussion of the arguments for and against BOT projects, see id. at 42-45.

(38) Andrew Adonis, "Investors Move as Asia Gets on the Phone," *Fin'l Times*, June 2, 1993.

(39) "Thai Bourse Waits For Telecomasia's Flotation," *The Reuter Asia-pacific Business Report*, Nov. 1, 1993.

(40) *See* Takashi Masuko, "Thais Pick NTT for $1.6 Billion Phone Network," *The Nikkei Weekly*, November 2, 1992.

(41) Michael Richardson, "More Time and Money to Communicate; Market Soars for Phones and Data Transmission Services," *It'l Herald Trib.*, December 10, 1992.

(42) *Indonesian Commercial Newsletter*, November 11, 1991.

(43) *PWFinancing*, October 1993 at 45.

(44) Under the new policy, each operator will be required to operate a minimum number of local exchange lines. In addition, for every line installed in an urban area, the operator must install one line in a designated rural area. See "Philippines - New Telecommunications Policy," 1993 *National Trade Data Bank, Market Reports*, August 17, 1993

TELECOMMUNICATIONS SECTOR REFORM IN ASIA:

TOWARD A NEW PRAGMATISM

by Peter Smith and Gregory Staple *

ABSTRACT

The reappraisal of telecommunications policies in Asia is underway as governments adapt their policies to meet changing technological and economic conditions affecting telecommunications supply and demand and, in particular, attempt to respond to chronic unmet demand for telecommunications services. Economic rationales, involving economies of scale and scope, and externalities, to support monopoly provision of service are challenged. Four main elements of telecommunications sector reform are reviewed: supply diversification, private sector participation, regulation, and implementation of reforms.

1. The Asia-Pacific region now has the most dynamic and rapidly growing regional economy in the world. A crucial question is whether the region's telecommunications sectors, apart from those in the half-dozen wealthiest states, can keep pace with the region's growth and expansion. Their ability or inability to do so will affect the region's economic prospects, especially those of the low- and middle-income countries (LICs and MICs), well into the next century.[1]

2. There is reason for optimism. It is generally agreed that the limited attention accorded telecommunications in the past and the prevalence of state-run monopolies has cost Asia's poorer countries dearly, economically and socially. Today more than 2.8 billion persons in Asia's LICs have access to little more than 25 million telephone lines. This has prompted nations as different as China and Sri Lanka, and Thailand and Indonesia to make rapid expansion of their telecommunications infrastructure a priority.

3. China, for example, has set a target of installing 4-5 million new telephone lines annually to 1995, and at least 8 million lines per year thereafter, to more than triple the current base of 17.5 million lines by 2000. Similarly, Indonesia aims roughly to double its base of telephone lines, to more than 2.5 million, by 1995 and add another 5 million lines by 2000. The new investment required for these and other programs in Asian LICs is estimated to exceed $90-$120 billion for switching and transmission facilities alone.

A New Pragmatism

4. The economic and political challenge of raising these funds and meeting the underlying demand for services has given birth to a new pragmatism in sector policy. The role of state-owned monopolies is receding, and investment by private companies in the telecommunications sector is growing; the range of telecommunications suppliers also is increasing, especially for wireless services (e.g., cellular radio), and regulation is being refashioned.

5. The impact of these new policy initiatives, if sustained, may be profound. Asia's LICs and MICs are home to almost half the world's population. But the will to adopt and implement a new direction for telecommunications varies greatly from one country to another. In India, for example, despite the estimated demand for 40-60 million new lines, the debate over how best to increase supply is unresolved. And in the Philippines, although the telecommunications sector is almost entirely privately owned, its performance has been disappointing.

6. This report concludes that if the new

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pragmatism on telecommunications policy is to succeed in doubling, or even tripling, the region's telephone base, current policy initiatives will need to be broadened and deepened. Recent international experience and sector studies suggest that the following points are of utmost importance.

(a) The cost to national economies of only providing very limited or no telecommunications service to millions of people will be, in most cases, greater than any loss of economies of scale and scope from franchising new service providers.

(b) The very small base of telephones in most LICs (fewer than two lines per hundred population) means that divestiture and privatization of a state-owned operator is, at best, a partial solution to closing the gap between demand and supply. More important than this "top-down" approach are likely to be various "bottom-up" approaches, funded by a mix of public and private capital, involving new concessions to independent wireline and wireless (cellular radio) telephone companies, build-transfer schemes, joint ventures, and revenue sharing contracts for transmission and switching facilities.

(c) A broadly available, mature telephone network is not a prerequisite to liberalizing market entry. To the contrary, the history of wireline and cellular service teaches that where telephone density is low, licensing multiple service providers is probably the best way to accelerate the investment necessary to create a more broadly based and mature national network.

(d) New service suppliers are unlikely to obtain reasonable interconnection terms from the incumbent operator without regulatory aid. Regulation is thus essential to foster the type of bottom-up investment necessary to close the telecommunications gap in Asia.

Background

7. The reappraisal of telecommunications policy in Asia is part of a wider international process that began in the 1970s. In rich and poor nations alike, governments are trying to adapt their policies to meet the changing technological and economic conditions affecting the supply of telecommunications services on the one hand, and to satisfy the rising and more diverse demand for services on the other. Telecommunications now touches almost every sector of the economy: farming and finance, tourism and textiles, merchandising and manufacturing. Thus, getting sector policy "right" is of great economic consequence.

8. At the center of the current policy reappraisal are questions of structure: Should more than one telephone company be permitted? And if so, should the market be divided geographically (by region), functionally (by service), technologically (by transmission method), or otherwise? The answers to these questions are still being debated, but the conventional view, which favored one supplier with a legal monopoly, a pyramid-like network architecture largely dependent on wireline facilities, and a homogenous product, is rapidly losing support.

9. In the past, a centralized, state-owned monopoly was preferred by most countries because basic telecommunications service was thought to be a natural monopoly -- i.e., economies of scale and scope made it more efficient for one company to provide service. However, the changing pattern of demand and falling switching and transmission costs appear to have made telecommunications a competitive industry for the majority of services including, in many cases, basic telephony. The most efficient structure for the sector thus is one that is plural and competitive, with a mix of service providers, private and public, using various technologies (wireless and wireline) and offering heterogeneous services to meet the different needs of users: in sum, a community of networks.

10. The case for a plural industry structure has gained additional support from the belief that where demand for service is not being met and the existing supplier is unresponsive, the economic cost to users and the national economy from continuing the status quo is much greater than any loss of economies of scale and scope from franchising new providers.

11. Local economic reforms also are spurring a reappraisal of telecommunications policy in Asia. Throughout the region, liberalization of trade and foreign investment rules, banking reforms, export promotion schemes, and increased reliance on market forces have made access to high-quality telecommunications services ever more important. Improved telecommunications now is generally seen as a vital component of a multistaged structural adjustment because efficient information flows foster the wider introduction of product and service markets. Further, because many of the light manufacturing businesses (electronics, auto parts) and labor-intensive products (garments, leather goods, agricultural produce) which Asia's LICs export are sensitive to shifts in foreign economic conditions and tastes, reliable telecommunications facilities are often crucial to the very businesses that are at the forefront of these reform programs. The pressure on LICs to address the shortfall of the telecommunications sector consequently is often more urgent than in industrialized countries.

12. Achieving agreement on the proper response to the telecommunications crisis in Asia, as elsewhere, has proven to be a contentious and often drawn-out process.

International precedents are rarely decisive. Most of Asia's telecommunications policy makers now have some familiarity with sector reforms in South America (Argentina, Mexico, Venezuela), various Commonwealth states (the U.K., Australia, Canada, New Zealand) and Japan. But, although these initiatives offer important lessons, programs that seem promising in a country that already has five or ten telephone lines per hundred persons (let alone 30 or 40) may be wholly inadequate where there are fewer than two telephone lines in service per hundred persons, as is the case in most of Asia.

13. In such countries, privatizing the state-owned carrier may have only a small impact on sector performance. The base of telephones is simply too small and the demand too great. The overriding issue is, how best to mobilize other sources of capital, especially from the private sector, to meet the demands of the great majority of people who must now do without any telephone service. In these circumstances, traditional arguments that market liberalization (i.e., competitive service suppliers, independent telephone companies) will impair the ability of the existing operator to promote nationwide service are not persuasive: the current service is anything but universal and, in the absence of changed policies, the prospects for achieving significant improvement are small. Further, in many Asian LICs, competitive entry is likely to accelerate network expansion by providing additional channels for investment as well as by improving technical efficiency through greater use of foreign expertise.

14. Likewise, arguments that multiple service providers are inefficient make little sense in a country where the telecommunications network covers only a fraction of demand. In India, for example, the gap between current supply (approximately seven million lines) and potential demand is so large that worry about "excess" or duplicative investments is, at best, a distant concern. Of necessity, therefore, Asia's LICs and MICs will increasingly become a test-bed, technically and institutionally, for building out telephone networks in innovative ways.

15. This is already happening in several countries. Yet if the new pragmatism is to succeed, it must be extended along several dimensions. For instance, liberalization has already led some countries to grant new licenses to provide value-added services (electronic mail, store-and-forward facsimile) on a nationwide basis, while telephone service, which is geographically limited to a small fraction of the population, is still a countrywide monopoly. In some countries, competing cellular radio licenses have been granted in major urban areas, but the new licensees are not authorized to construct microwave radio links to provide intercity or regional coverage. Elsewhere, private companies are permitted to install very small aperture terminals (VSATs) to ensure reliable satellite-based communications, but they may not resell the excess capacity to other users. Further, the failure of a monopoly operator to provide service has prompted governments to launch "crash programs" to construct new exchange facilities with foreign partners but, once built, all new facilities must be turned over to the existing monopoly operator.

16. Similarly, despite the significant resource constraints the region faces, many countries have continued to favor capital-intensive programs for expanding access to telecommunications services rather than employing more decentralized and often less expensive access options that new technologies are making available. Household telephone service is favored over public pay telephones, land-line extensions over wireless systems, cellular radio over trunked mobile and paging services, new telephone exchanges over voice mail, and contiguous (predominantly urban) telephone networks over stand-alone or independent ones.

17. Against this background, a key question today is, how can Asia's LICs and MICs begin to move their new pragmatism from the periphery to the center of the telecommunications reform agenda? This paper makes a number of suggestions to help promote that shift.

Economic Principles

18. The traditional argument that the telephone industry is a natural monopoly remains controversial. Moreover, the existence of economies of scale and scope, per se, has limited significance for policies toward entry of new service providers. If entrants do not impose congestion costs on incumbents and interconnection is not foreclosed, either by the exercise of market power or by relatively high transaction costs, it can be argued that a laissez-faire attitude toward entrants on the part of government policy makers is warranted, especially for low-income countries, which tend to suffer chronic capacity shortages and other inefficiencies on the part of protected incumbent suppliers.

19. Arguments that network externalities or other external economies mitigate against the benefits of competitive entry implicitly assume that interconnection among competing networks is either not possible or that would-be subscribers discount the possibility of interconnection. If, for one reason or another, the market cannot efficiently promote interconnection within both the toll and local sectors as well as between toll and local, there is a case for public policy intervention. Examples of policies to promote competitive entry in the United States include the mandatory unbundling of basic exchange services and mandatory interconnection.

20. Arguments against allowing competitive entry also tend to minimize the existence of users with diverse needs and priorities. Heterogeneous demands on the part of telephone users accentuate the advantages of having a number of rival suppliers, since it is unlikely that any single supplier could satisfy a broad range of heterogeneous customers. Even in the

case of "plain old telephone service" (POTS), the speed with which installations are made and the commitment to maintaining quality are relevant dimensions of performance. Given the more limited experience of telephone operators in low-income countries compared to that of operators in high-income countries, there is likely to be greater heterogeneity among suppliers of POTS in the former countries than in the latter. This strengthens arguments for allowing diversity in the supply of telephone services in low-income countries.

Diversifying Supply

21. Once a government is persuaded that encouraging new service suppliers is more likely to close the gap between demand and supply than maintaining the status quo, hard choices still must be made about where to start and how to proceed. This section argues that liberalization should be given a high priority in the area where the shortfall of supply typically is the greatest: local exchange service.

22. By and large, governments should adopt a "serve it or lose it" policy to require carriers to meet the paid demand for new service within a given time or face the prospect of (a) having a competing company licensed to provide service or (b) having portions of their service territory refranchised to other carriers. The histories of wireline and cellular radio service both suggest that a broadly available, mature telephone network is not a prerequisite to liberalizing market entry. In fact the opposite is true: licensing multiple service providers probably is the best way to accelerate the investment necessary to establish a more broadly based and mature national telecommunications network.

23. Liberalizing market entry does not require a vertical divestiture of the existing carrier, although that may be desirable in some cases to promote equitable interconnection. At root, a serve-it-or-lose-it policy should be designed to lift the artificial (legal) barriers to market entry which to date have blocked the type of "bottom-up" network expansion programs led by independent local telephone companies, municipal enterprises, and public-private joint ventures that successfully developed telephone service throughout North America and Finland during the early twentieth century and are playing a major role in building out China's telephone network today.

24. Any policy to liberalize the provision of local exchange services should be technologically neutral; wireless operators (such as those using cellular radio) should be permitted to meet the demand for both mobile and fixed service. Further, government policy should be institutionally neutral; private and public enterprises (including municipalities and cooperatives) should be able to apply for service licenses.

25. In many cases, the liberalization of local exchange service might be complemented by introducing competition for long-distance transmission services, although generally this step is not needed as urgently. Competitive transmission networks for long-distance telephony have proven viable even in relatively small countries with approximately 1 million exchange lines (such as New Zealand), and it is likely that competition would be beneficial in other Asian countries (India, China, and Indonesia, for example). The growth of domestic satellite carriers might provide a platform for a second long-distance carrier in some of these countries.

26. Competition for transmission service (local or long distance) does not mean that a government must abandon subsidies for socially desirable services, where they are necessary. The key is properly to cost out the desired subsidies and assign the cost equitably among carriers so that they can be recovered through network connection charges or (preferably) general tax revenues.

27. Even where a country decides to proceed slowly with facilities-based competition for local or long-distance service, resale of the monopoly carrier's service offerings should be permitted. At a minimum, companies must be free to lease dedicated circuits in bulk and to resell them to provide value-added data processing and information services to business and residential users. Value-added service providers should also be permitted to own the necessary switching facilities they need to operate their businesses efficiently.

28. Serious consideration also should be given to the introduction of basic resale services. Experience suggests that resale leads to price and service competition (custom calling plans, volume discounts, and itemized billing options, for example) which would otherwise be unavailable. It also encourages the underlying carrier to adopt a more cost-based tariff structure, and thus to operate more efficiently to reduce the margin for resale.

29. Governments should speed up the liberalization of telecommunications terminal equipment. The benefits of allowing users to buy or lease the equipment of their choice, subject to appropriate measures to ensure that technical standards are met, have now been demonstrated in numerous countries. Asian LICs are in a position to reap a harvest of benefits from the successful experiences of others.

Increasing Private Sector Participation

30. Fostering more private investment in telecommunications is already an important part of most sector reform programs in Asia. But the privatization or divestiture of the state-owned carrier is only one measure among many and, given the very low telephone penetration in Asia's LICs, may not be the most significant for boosting private investment. Of greater importance may be fostering bottom-up schemes for private-sector entry to the market to promote construction of new telecommunications facilities by a mix of independent enterprises.

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31. A large body of international experience with the divestiture of state-owned telecommunications operators suggests the importance of several common procedural and substantive issues. They include the need (1) to state clearly the objectives for divestiture at the outset; (2) to allow sufficient time to prepare a carrier for sale (typically two to three years); and (3) to secure the legal conditions for sale, which usually involve adopting a legislative reform package and organizing a regulator that is independent of the incumbent operator. Experience also suggests that the success of a divestiture will be decisively affected by the economic incentive reflected in the price-control rule and the network performance targets, both quantitative (number and location of access lines to be added) and qualitative (number of permissible faults and response to outages).

32. New entry and other "bottom-up" measures for private-sector development are likely to become increasingly important in Asia's LICs, and they may become the prevalent means of closing the gap between demand and supply. They may take several forms: competitive franchises granted to independent telephone companies in designated areas; refranchising of unserved or underserved areas of the country; capital provided by municipalities or the private sector through a build-transfer scheme; or a joint venture. The service provider may be a stand-alone company or a subcontractor for an existing licensee; the scope of service may be limited to local exchange services or may extend to interexchange offerings.

33. A bottom-up program for promoting more private investment, like a top-down divestiture, will not be effective without matching regulatory and institutional commitments. Among other things, where multiple operators are to be licensed a clear policy decision must be made regarding interconnection and pricing. However, full interconnection will not always be necessary for all services because, as with electronic mail and database services, some subscribers may be satisfied initially with self-contained networks, the growth of which may in fact speed new service to users.

Regulation

34. Regulation has been the weakest part of sector reform in poorer countries, and Asia's LICs are no exception. If this deficiency is not addressed, ambitious plans for sectoral expansion are likely to be compromised because effective regulation, to the extent it contributes to establishing appropriate incentives, is essential to attracting substantial amounts of private capital to telecommunications.

35. Regulation must be broadly understood to include a country's political and judicial competence as well as its commercial customs. Whether or not an effective regulatory regime can be designed for telecommunications (or any other industry) will depend on how well the new regime fits with existing governmental institutions. Regulatory designs cannot easily be transplanted unchanged from one country to another.

36. The increasing scope for competition and private service suppliers in the telecommunications sector have led some to argue that no special public utility or common carrier rules are needed: the general application of competition laws will be sufficient. Experience in several countries (New Zealand, Mexico, and the U.S.) suggests that the "no regulation" option is illusory. One principal reason is that new service suppliers are likely to be stillborn unless they can interconnect their facilities with the incumbent carrier's network on reasonable terms. Without regulatory intervention, however, interconnection has proven to be unsatisfactory. Further, absent regulatory oversight, either the dominant carrier or the ministry responsible for the carrier become the de facto rulemaker for the sector, often to the disadvantage of would-be competitors and consumers.

37. It is desirable that market liberalization be accompanied by the creation of a regulatory body at arm's length from the dominant operator. Further, there are advantages to organizing the regulator as a multimember commission rather than a single director general, in part to spread the workload; continuity can be provided by staggering the terms of a multimember commission. In any event, the regulator should have a clear legislative mandate, secure funding, and a staff of competent professionals. The regulatory process should be accessible to both the regulated providers and to users. Relevant policies and rules should be published and adequate scope provided for public participation in their formulation. A politically strong, professionally competent, and publicly accountable regulatory commission is most likely to be able to employ a light-handed approach to regulation appropriate to many situations.

38. The scarcity of regulatory resources in LICs makes setting priorities especially crucial. In this regard, interconnection matters, the price-control rule for the dominant supplier, policing transactions with affiliated companies, frequency management (which directly affects the options for market entry), and data collection deserve to be at the top of the agenda. Further, the time required to address each of these matters may be reduced by writing clear price and performance standards into carrier licenses or concessions; outside contractors can be used to monitor these standards.

39. Other regulatory functions such as frequency allocation can also be contracted out and the cost recovered from user fees. The initial licensing decision, however, should be made by the government.

Implementing Sector Reform

40. The timing and sequencing of reforms is crucial. There is frequently a fairly short period to launch a reform program, often tied to the calendar of a government's overall economic program as well as to election cycles. A purely technocratic initiative which does not adequately consider the overall context of a reform program and the need to manage a restructuring process over several years (even divestiture is never a singular event) is likely to fail.

41. Most countries, including those in Asia, have followed a sequential approach to market liberalization. Typically, the terminal equipment market is opened to competitive supply; then value-added services, satellite-based and wireless services (mobile radio, paging) are liberalized; finally the market for basic switched services is opened to competition, starting with interexchange services. Such a progression may be beneficial where a country has limited experience with managing economic restructuring and a new regulator must be put in place. However, sequencing may have an unacceptably high cost where there are very large unmet demands for service -- demands that might be more quickly satisfied by lifting barriers to market entry at the outset, not toward the end, of a sector reform program. Beyond that, incrementalism may dissipate public support for reform: once expectations have been raised, possibly only a bold initiative that makes a real break from the past will be acceptable.

42. Notwithstanding the drawbacks to incremental market liberalization, experience suggests that a step-by-step approach to divestiture is essential. Unless divestiture is preceded by a restructuring process in which the state-owned carrier is commercialized and the government's regulatory responsibilities are separated from its policy-making and operational roles, the sales price of the carrier may be reduced and sector efficiency greatly hurt in the postdivestiture period.

43. International experience has also shown that a successful telecommunications reform program must have the unflagging commitment of the head of government. A nation's telecommunications network, no matter how underdeveloped, is one of its chief national assets, and the complex task of restructuring the sector, let alone managing a divestiture with competing economic, social, and national security interests involved, cannot be effectively carried out without strong leadership.

44. Such leadership is a necessary, but not a sufficient, condition for change. For that to occur, a cross-government and cross-private-sector coalition must be built. Again, experience shows that momentum for reform comes most often from without (e.g., outside the state-owned Post Telephone & Telegraph Department (PTT)), not within, and reform is most likely to move forward if championed by a broad coalition of users and would-be suppliers. Telecommunications sector reform may also be hastened by links to other sector-reform programs. Initiatives to restructure the electric power sector, which is often also dominated by a poorly run state monopoly, may be particularly instructive.

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[1] Based on 1990 per capita GNP, Asian countries may be classified as *Low-income* ($610 or less): Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Lao PDR, Mynamar, Nepal, Pakistan, Sri Lanka, and Vietnam; *Lower-middle-income* ($611-2,465): Malaysia, Philippines, and Thailand; *Upper-middle-income* ($2,466-7,619): Republic of Korea. *World Development Report* 1992 (Oxford U. Press, New York, 1992) p. 306

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Improving International Telecommunication Services in Areas Requiring Network Development

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Abstract

An outline will be presented of a project undertaken in the Far Eastern region of Russia as an example of one approach to improving international communication services in areas with inadequate telecommunication infrastructure.

1. Introduction

With the growth of the world economy, there has been an increase in demand for international telecommunication services to and from developing countries and regions, and carriers in the developed countries have come under pressure to devise ways to rapidly expand international circuits in order to facilitate access to such areas.

However, the real bottleneck in improving such services has been delays in the development of domestic telecommunication networks, which typically requires vast sums of money and long-term construction.

The development of a domestic communication network, even more so than that of an international one, has been seen as pertaining directly to the basic infrastructure of the country concerned, and when foreign enterprises have become involved in such projects, due respect has needed to be shown to national sovereignty in the telecommunications field.

Official development assistance (ODA) has been provided by developed countries along with funding and technical aid from international agencies in order to help with the installation of domestic communication networks. Such assistance has invariably taken the form of support for network installation projects designed by the particular country where improvements in communication services are required.

In recent years there has been an increase in the number of nations that desire to rapidly upgrade their communication networks soliciting investment and technical assistance from overseas carriers on a commercial basis, outside the framework of ODA, on the prospect of future revenues to be enjoyed from the network in the expectation that it will generate a profit; carriers responding to such overtures either acquire development rights or conclude an agreement with the country concerned.

Among the technologies utilized in such

projects are very small aperture terminal satellite (VSAT) systems and digital overlay networks, while financing may take several forms, including build, operate and transfer (BOT) schemes and joint ventures.

2. Joint Venture Project

A specific example will be presented below of an area with inadequate communication services in which rapid improvements had to be made in network conditions by means other than ODA. A review will be offered of the background to this case and the solutions that were implemented.

With the laboriously slow pace of the Russian Republic's progress in independently setting up a domestic communication network, the Russian communications ministry has found itself with little choice but to foster the development of the international network that is essential to the country's commercial and economic growth while maintaining control of the construction of digital overlay networks through the licensing of foreign-affiliated joint ventures in regions such as Moscow where. foreign enterprises have established a presence.

Demand for service to the Far Eastern part of Russia, with which Japan was enjoying an expansion of economic and cultural ties, had been growing annually, while at the same time the inadequate state of Russia's domestic network led to calls for improvements in communication links between the two countries.

In addition, local governments in Russia's Far Eastern region were rushing to lay down infrastructure with the aim of attracting foreign investment to support economic growth in the region. Some local government official of the region darted around Europe as well as Asia in search of partners to provide funding and technical assistance for improving the international communication network, one such infrastructure project.

Meanwhile, in March 1991, a consortium of Russian parties put up the capital to establish a Russian private international communications firm, INTELDALTELECOM (IDT), in Vladivostok, a city with the potential to become the hub of economic activity in the Far East region, with the goal of independently undertaking immediate steps to upgrade the communication system. To this end Japanese assistance was solicited.

IDT originally intended to fund the establishment of an international network on its own. Therefore KDD concluded a memorandum of cooperation with IDT on furnishing technical assistance in making the required improvements.

However, Russian funding shortages made it impossible for IDT to acquire the necessary equipment, ultimately forcing it to abandon its plans for independent action.

At the time there was growing demand among Japanese and other foreign companies active in Russia's Far Eastern region as well as among Russian firms for the commencement of facsimile and high-quality telephone service at the earliest possible moment, while it was anticipated that considerable money and time would be required in order to accomplish a complete overhaul of the existing public telephone network. Therefore KDD began to examine ways to assist the Russians in overcoming the impasse and implementing the needed improvements on a timely basis, as the result of which it was decided to set up a Russian-Japanese joint venture by the name of VOSTOKTELECOM Co., Ltd., which was to be involved in constructing the necessary facilities and establishing a new network for carrying international calls as soon as possible.

Other forms of cooperation (such as a BOT scheme or loan program in the field of financial assistance) were considered before it was decided to settle on a joint venture. Among the reasons that can be cited for the choice of this particular option are the fact that the transfer of a certain amount of expertise on installing international communication networks was seen to be necessary, as well as the need to ensure effective management and operation of international communication services through the dispatch of personnel from Japan.

There was also the consideration that the existence of a common objective, namely joint management of a joint venture company in a sound, businesslike manner, would act as an incentive, enabling the transfer of expertise to the Russians to proceed as rapidly as possible and thus allowing the prompt overhaul of the communication network.

Therefore the cornerstone of the relationship with our Russian partners was the idea of working hard to generate a profit early on, then applying that profit to further upgrading the communication network in the Russian Far East.

Certainly there were frequent disagreements on business management and ways of getting things done, since the partners in the joint venture company came from different environments, cultural backgrounds and economic and political systems, and disputes did take place.

Nevertheless, there was an awareness of how important promptly establishing a communications infrastructure was to plans for the economic development of the region, and the realization of the responsibility we shared through our involvement in a project that was an integral part of this mission enabled us to compromise and keep up our efforts to get the project off the ground. As a result it proved possible to commence international service with amazing rapidity.

A survey of the current state of the communication network in the Far East region was carried out as part of the feasibility study undertaken before the joint venture was set up. This revealed that virtually all the facilities were out-of-date and in a poor state of repair due to failure to invest in replacement equipment. Deterioration of communications equipment as the result of aging was identified as the reason for the low quality of international telephone service heretofore. While this was the case also with transmission lines, the chief culprit turned out to be telephone exchange equipment in cities, which was old and in poor condition.

It was originally planned to set to work on improving communication services in a limited area of the Russian Far East centering on Vladivostok, but communications authorities in other districts in the region with inadequate network conditions also expressed their desire to participate in the project. Communication authorities in Sakhalin, Irkutsk, Yakutsk and Nakhodka joined INTELDALTELECOM, the Russian partner in the project; in addition, the Far East Railway Bureau came on board from Khabarovsk with its own independent telephone network. Therefore electronic automatic switching systems for local connections were newly installed in these cities, while an international transit switching system (INTS) was set up in Vladivostok, resulting in an international communication network covering almost the whole of Russia's Far Eastern region.

One of the factors that can be cited behind this development is the crucial importance of improving communication services, especially international communication services, as part of the infrastructure for supporting economic growth in these areas. In fact local governments in the Far East region have for some time been asking communication authorities to effect improvements in service, and such projects as the present one involving the investment of capital from overseas have enjoyed the warm reception and support of various levels of government, including the local government of the coastal region where Vladivostok is located.

These efforts to upgrade the communication network should continue to make steady progress in the future. In light of how the aforementioned governments have responded, it is clear how urgently needed a new network such as that established by VOSTOKTELECOM was in order to attract greater investment into the Far East region.

Of course, given the various circumstances affecting this telecommunications project and the joint venture established to carry it out, including the chaotic political and economic situation in Russia and the lack of relevant legislation, the decision to invest was not one to be taken lightly, and there were limits to how much a private company could accomplish solely through its own efforts.

That under such conditions a Japanese firm proved able to play the role of investor in the development of this communication network is due in no small part to the tremendous support and understanding shown to the project by the governments of Japan and Russia.

While the Russian-Japanese relationship is plagued by many unresolved issues, agreement does exist on the need to strengthen contacts. One means to do so is by improving communication links, and when urgent action became necessary in this area the governments of both countries were forthcoming with their support.

The VOSTOKTELECOM Project was launched with the goal of improving communications between Japan and the Far East region of Russia, but a number of inquiries and requests relating to the network have come in from organizations in other countries wishing to gain a foothold in the region or establish contacts with it. KDD has been cooperating with carriers in such countries both through the conclusion of service agreements on transit calls and by helping arrange to establish direct telephone links. As of September 1993 the VOSTOKTELECOM Network had been put in two-way contact with 26 regions, including the United States, South Korea and China, a figure that should increase considerably in the future.

This small communication link that has been set up in the Far East region is rapidly evolving into an extended network, which can be expected to grow in step with economic development in the region.

DEVELOPMENT OF THE TELECOMMUNICATIONS SECTOR IN LESS DEVELOPED COUNTRIES: INVESTMENT, REGULATORY AND PERSONNEL CHALLENGES

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1. ABSTRACT

Development of the telecommunications sector is vital to national economic development in less developed and post-Communist countries. In most such countries, telecommunications development faces three major challenges: investment requirements; sector and regulatory reform; and personnel, training and organizational problems. A detailed analysis of these three areas, with particular emphasis on the little-researched area of personnel management, shows that those countries that tackle these three challenges successfully will find telecommunications serving as a spur rather than a drag in the race for national economic development.

2. INTRODUCTION

Telecommunications are often called the nervous system of commerce and industry, without which no national economic development strategy can succeed. This paper provides an overview of challenges faced by non-industrialized countries in improving their telecommunications sectors, with a focus on three key areas:

- Investment requirements
- Sector reform and regulatory changes needed to incorporate private energies into the sector
- The little-studied area of personnel, training and organizational problems faced by less-developed telecommunications entities.

The first two areas are dealt with rapidly, since they are familiar to most telecommunication observers. The last area is dealt with in depth, since this area has not been well researched in the past.

3. INVESTMENT REQUIREMENTS

In 1984 the Maitland "Missing Link" report stated that "telecommunications should be regarded as an essential component in the development process." Currently most analysts agree that increasing phone penetration (usually measured in phone lines per 100 population) is both a cause and an effect of increasing economic development. Furthermore, there seems to be a ceiling of about 30 lines per hundred population below which it is difficult or impossible to reach industrialized-country levels of development, and above which virtually all the Western industrialized countries (including Japan) are located.

To reach this level will require a massive, rapid and efficient infusion of capital and construction expertise. In 1984 the Maitland report estimated that a total investment of $12 billion per year would be required to improve and expand the networks of the developing world. The current worldwide situation has been analyzed by Dr. Timothy Nulty of the World Bank, who estimates that:

> To have a chance of reducing the gap between themselves and the industrialized countries, most NICs and LDCs must accelerate telecommunication network growth from the range of 3-4 percent per annum to around 10 percent per annum. This will require devoting at least 1-2 percent of GNP to telecommunication investment. To accelerate to 10 percent per annum in the non-OECD countries will require something like $300 billion over the next decade. This demand for capital...will tax all available sources.[1]

Similar estimates have been done for the former Communist countries, most of which are seeking to reach the level of 30 per hundred penetration by the year 2000. These estimates show that to get from their current average penetration of about 10.5 lines per 100 population the target of 30 lines in seven years, by the year 2000, will require an investment of roughly $141 billion (!), and that a comparatively large share of each country's GDP will have to be devoted to telecommunications construction.[2]

By comparison, it took European upper and middle income countries quite a few years to complete similar construction programs. For example, while France took only 5 years to go from 13 to 30 penetration, West Germany took 9 years, Spain 14 years, and Belgium 17 years.

Realistically, it appears that while some countries in the developing world and former Warsaw Pact will have the commitment and the drive to devote their own resources to this sector and obtain multilateral and foreign investments, many countries will not be able to achieve this. For these lagging countries, telecommunications will serve as a drag rather than a spur to economic development.

Performance Appraisals

Many developing telecommunication organizations skip performance appraisals or rate almost all their employees as "excellent" or "outstanding" (see Figure 7). Obviously a more normal curve distribution is needed to provide any meaningful feedback to employees.

In some Asia/Pacific telcos performance appraisals are written up and put into the individual's personnel file, but kept secret from him, due to a cultural fear of face-to-face confrontation.

Pay Systems

Pay systems in developing telcos are often not appropriate to achieving new organizational goals (see Figure 8). Civil service-style pay systems, with the traditional steps and grades, tend to give little incentive for phone workers to produce. Yet many phone worker operations are amenable to piece work, bonus, incentive or other systems which reward high production.

In the former Communist countries, pay systems are almost always very flat, with almost all employees (from policy makers to managers to blue collar workers) closely clustered around an average salary. (Really senior officials were often rewarded with non-monetary perks such as better living accommodations, a car, etc.). Thus there is little incentive to work harder within one's present job, and little incentive to try to get promoted (unless one gets near the top). Pay levels for telecommunication workers in these countries are usually very low, leading to taking of second jobs and possible future "brain drain" to the emerging private sector and the West.

The approach that is needed in the developing world and in former Communist countries is a system that combines individual and team bonuses, to incentivize excellence, team cooperation, and competition between regional or other teams within the company (Figure 9). Excellent performance by individuals and teams should lead to pay that is at or slightly above the market pay rates, to prevent "brain drain."

Developing pay systems and pay levels that are appropriate to the organizational goals and are comparable to the emerging private sector will and should be a high priority in the future in the developing and post-Communist telcos.

Benefits

Often developing telecommunication organization's benefits are as good and sometimes better than the emerging private sector's (see Figure 10). This is probably because the state-owned and over-staffed PTTs have found it easy and cheap to offer low cost perks in place of adequate salaries. Often in the former Communist this leads to individuals retaining their PTT jobs (from 7:00 a.m. to 3:00 p.m.) for the sake of the benefits, while taking an afternoon private job (from 3:00 p.m. to 7:00 p.m.) for the sake of the money. Sometimes such jobs have built-in conflicts of interest. What is needed here is an analysis of market levels for benefits and a migration strategy to move to market based benefits.

Overcentralization

Usually developing telecommunication organizations are over-centralized for their modern functions. High centralization was appropriate when the (implicit) goal was slow growth of telephone penetration and constant control and checking of subordinate's activities. Now that the goal has shifted to fast growth of phone penetration, much more decentralization is essential. Overcentralization leads to three key problems: low probability of approval for essential actions, slow decision making time, and overloading and trivializing of top management decision making (see Figures 11 and 12). But overcentralization is one of the most difficult management traits to let go of. What is needed here is the will to decentralize and delegate, especially in the important area of authority to purchase needed items. While detailed studies may be necessary to determine the optimum level of decentralization, the major obstacle here is usually internal resistance, not lack of management studies.

Internal Communications

Often developing telecommunication organizations have problems communicating across internal unit lines. This is especially true when it comes to communicating between the engineering/operations area and the finance area. Finance specialists in the old regime often had a very low level of authority and prestige, and were viewed simply as very basic accountants who costed out the engineers' construction plans and passed them on to the central Treasury for approval. No Western-style financial analysis or forecasting was usually done, and the accountants rarely questioned the engineers.

In the new evolving system, now that resources are very scarce, the economic viability of projects has become paramount, and close interaction between engineers and highly trained financial analysts is necessary. Thus the authority, training and prestige of the financial function will need to be raised substantially.

The necessity for greater interaction carries over to many other areas, where functions which could operate fairly autonomously under the old regime now need a great deal of lateral communication in order to succeed (see Figure 13).

Training

The most obvious problem faced by developing telecommunication organizations, a problem especially noted by the Maitland report, is the low "training rate" (see Figure 14). A high training rate is vital in a dynamic organization with changing technologies. But in Thailand, for example, the training rate is about 5 times lower than what is often recommended. Even if one allows for the fact that developing PTTs may be overstaffed by 30 percent or more, these kinds

FIGURE 5
MANPOWER PLANNING IS USUALLY VERY LIMITED, DUE TO THE STATIC NATURE OF THE ORGANIZATION

Typical Situation Around The World	Future Needs	Examples
Minimal Measures of Manpower Productivity Exist (Usually Only "Lines Per Employee" or "Employees Per 1000 Lines")	Manpower Studies Needed To Establish Best Practices And Productivity Targets For All Key Job Categories	TOT Reached Goal of "68 Lines/Employee" (15.2 Employees per 1000 Lines) and Plans to go No Higher
No Manpower Planning Unit Exists, or is Inactive	Strong Manpower Planning Unit Able To Identify Needs And Rapidly Fill Them	
No Comprehensive Manpower Plan Exists	Comprehensive Manpower Plan Established, Linked To Corporate Planning System	Few East European PTTs Linked or Have Established Manpower Plan
Very Few Recruitments Performed, Little Outreach	Numerous Promotions And Transfers, Career Ladders Established	Antel (Uruguay) Recruits Only 40 to 50 Positions/Yr (0.5% of Workforce) Including Only 10 Professionals
Very Few Promotions Processed, No Career Ladders	Numerous Recruitments, Wide Outreach	Antel Promotes Only 100 Staff/Yr (1% Of Workforce)
No Recruitment From Outside Allowed	"Fresh Blood" Brought In At All Levels	Eastern Europe, TOT, MTPT, Antel All Recruit at Bottom Only

FIGURE 6
POSITION DESCRIPTIONS (PDs) ARE OFTEN PROBLEMATIC

IDEAL PDs	SOME ACTUAL PDs
Exist	Non-Existent
Specific About Job Tasks	Overly Vague
Include "Other Duties as Assigned"	Omit This Key Phrase
Flexible and Easily Changed (within 1 Month) by Management to Reflect New Organization and New Technology	Inflexible, Subject to Lengthy (6 Month) Union, Personnel Department, and Even Board of Directors Approvals
Individual Who Changes Jobs Moves Into New PD	Individuals Carry Their Old PDs Into New Jobs, Creating Conflicts

200

FIGURE 3
A LACK OF HIGHLY TRAINED ENGINEERS IS OFTEN A PROBLEM

ISSUE	COUNTRY	EXAMPLE
Low Percentage of Electrical Engineers on Staff	Uruguay ANTEL	Only 70 of 8000 ANTEL Employees Have EE Degrees (0.8%)
Declining Number of Engineers, Unfilled Vacancies	Indonesia MTPT	MTPT had 9 EE Vacancies in Early 1992 for 3 Years, Unable to Fill Any
Difficulty in Recruiting Engineering Technicians	Thailand TOT	Private Employers Pay Engineering Technicians with 2 Year Degree About $280/Month; TOT Pays $140/Month
Inability to Recruit From Best Schools	Indonesia MTPT	MTPT Had No Graduates of Best School in Country (Institute of Techology at Bandung)

FIGURE 4
THE BOOZ·ALLEN APPROACH IS OFTEN TO RAISE SALARIES FOR NEW RECRUITS AND FOR OLD EMPLOYEES WHO COMPLETE AN AMBITIOUS TRAINING PROGRAM

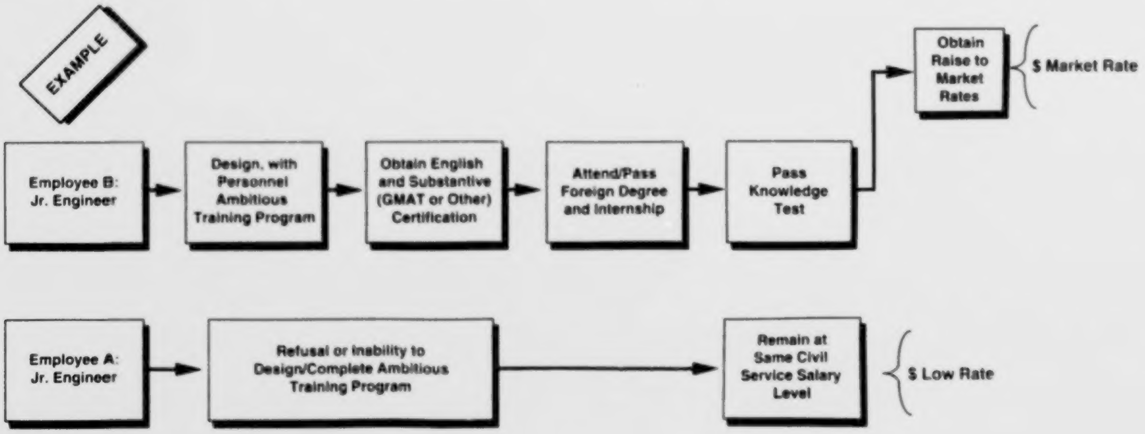
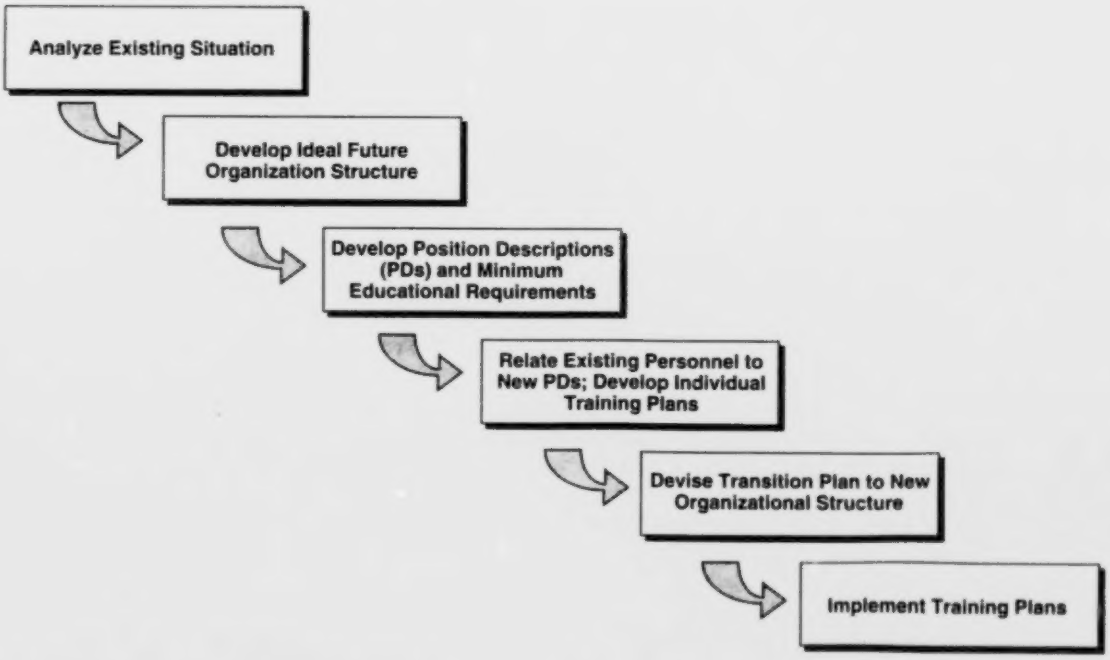

EXAMPLE
Employee B: Jr. Engineer
Design, with Personnel Ambitious Training Program
Obtain English and Substantive (GMAT or Other) Certification
Attend/Pass Foreign Degree and Internship
Pass Knowledge Test
Obtain Raise to Market Rates
$ Market Rate
Employee A: Jr. Engineer
Refusal or Inability to Design/Complete Ambitious Training Program
Remain at Same Civil Service Salary Level
$ Low Rate

FIGURE 1
MANY DEVELOPING TELECOMMUNICATION ORGANIZATIONS HAVE A VERY HIGH PERCENTAGE OF STAFF WITH INADEQUATE EDUCATION

Educational Level	Typical Asian Operator*		Typical Asian Ministry of Communications**		
	#	%	#	%	
Ph.D.	3	0.0	0	0.0	Highly Desirable
M.S.	67	0.4	1	0.2	
B.S.	1781	9.8	80	22.9	Acceptable
2-3 Yr. Degree	5579	30.7	25	7.2	
High School	1368	7.5	166	47.6	Unacceptably Low for Most Positions
Below H.S. or Other	9390	51.6	77	22.1	
TOTAL	18188	100%	349	100%	

* This is an operating entity and hence has a high percentage of manual workers
** This regulatory organization needs relatively few low-trained staff

FIGURE 2
THE BOOZ·ALLEN APPROACH TO THIS ISSUE INVOLVES SIX STAGES


Analyze Existing Situation
Develop Ideal Future Organization Structure
Develop Position Descriptions (PDs) and Minimum Educational Requirements
Relate Existing Personnel to New PDs; Develop Individual Training Plans
Devise Transition Plan to New Organizational Structure
Implement Training Plans

- While the PTTs were functioning as organs of government, employing a bureaucratic, leisurely, non-bottom-line approach was quite acceptable.

- The clients of the old PTTs were often not primarily the public and the business community, but rather were other state-owned enterprises (SOEs) and the national security apparatus. (In fact some Communist countries had a poor quality telecommunication system for the general public and unimportant SOE users, and a better-quality phone system linking the key decision makers in society—the central politburo, the armed forces, the party, the intelligence service, and the puppet media). Thus "serving the public" was never really a goal of the old system.

- Full employment had a higher priority than management efficiency. Management training was deemed to be unimportant or even completely unnecessary, since motivating personnel and making them efficient was less valued than controlling personnel and making them subordinate to top-down control.

- Sharing ideas across units within an organization, and especially across organizations, was not deemed to be important.

As a result of these and other causes, a myriad of challenges are now being encountered by developing and former Communist PTTs. These challenges, while obvious and important to the outside observer, are often not recognized by the PTT managers, for several reasons. First, most PTT managers and top telecommunication Ministry officials are engineers, who are usually much more interested in technologies and equipment than in personnel issues. Second, these organizations almost always are managed by insiders who have risen slowly through the ranks and are reluctant to change the only system they have ever known. Third, most of the money flowing into the PTTs is directed at rapidly addressing the engineering problems of the networks, not at the management problems of the organizations. Technical management and regulatory assistance is being offered and funded by various multilateral banks, but will probably take a long time to have a significant impact.

The significant challenges in this area can be divided into the following types:

- Educational level of the workforce
- Manpower planning
- Position descriptions
- Performance appraisals
- Pay systems
- Benefits
- Overcentralization
- Internal communications
- Training
- Labor relations
- Staff vs. line capacity.

Each of these is discussed below.

Educational Level of the Workforce

The educational level of the workforce in less developed telecommunication regulatory and operating entities in Asia, Africa and Latin America is usually much too low (see Figure 1). The increasing complexity of the sectors and the technologies of the future dictates a highly educated workforce, especially for the regulators. What is needed here is a multistage approach that involves developing a picture of the ideal future organization, and designing job descriptions and educational requirements to fit into that organization (see Figure 2).

In former Communist countries the situation is a bit different. Here the educational level, especially on the technical side, is often quite good. What is usually needed here is extensive education in business management, financial analysis, Western-style accounting, strategic business planning, and other "soft" subjects. Many developing telecommunication organizations need more highly trained telecommunication engineers (see Figure 3). This is often because the country only produces a few such engineers (e.g. Uruguay only produces 10 telecommunication engineers per year) and/or because the few engineers are snapped up by the better-paying, emerging private sector. The approach often required here is raising salaries for new recruits and for old employees who complete an ambitious training program (see Figure 4).

Manpower Planning

Often developing telecommunication organizations have little or no modern manpower planning capability (see Figure 5). Such manpower planning should have certain basic elements, such as a specified planning unit and clear links to the overall corporate or organizational plan. Developing telecommunication organizations had little need for such planning, since the organization was static, almost all hiring was done at the bottom rung only, direct from the universities and technical schools, and very few promotions were processed. All this will need to change in the developing world and in the former Communist PTTs.

Position Descriptions

Developing telecommunication organizations seem to have many difficulties with position descriptions (PDs—see Figure 6). In some countries they are non-existent and employees simply look to their boss for direction. In some countries they exist but are very vague ("the employee will serve the needs of the country and the PTT's customers..."). In some countries they are so specific and unchangeable that it can take months or years to alter them to fit reality or to accommodate new management initiatives. In at least one country the PDs move with the individual, so that an operator transferred to trench digging would retain the hours and many of the benefits of an operator, while performing trenching operations!

4. NEEDED SECTOR REFORM AND REGULATORY CHANGES

In 1984 the Maitland report stated that:

> It is for governments to decide whether telecommunications are publicly or privately owned, and whether competition should be admitted. But telecommunications should be run on business lines as a separate, financially self-sustaining enterprise. It should be properly managed with effective controls.

Due to the wave of privatization and sector liberalization that has and is sweeping the world in telecommunications and other sectors, most current analysts agree the old approach of having a state-owned monopoly provide all posts and telecommunications (or PTT—Post, Telephone and Telegraph provider) has now outlived its day.[3] This approach has tended to have telecommunications subsidize posts, provide low quality service, provide none of the business-oriented services now common in industrialized countries, be very non-customer driven, have telecommunication profits siphoned off by the Treasury rather than invested in more phone penetration, and generally serve as a drag on development. All of these problems were evident in the developing world and in the former Communist countries, with the result that service is often very poor, networks highly congested, and call completion rates low.

What many observers agree is needed in the future in most countries is the following sequential program:

- Separate posts from telecommunications where this has not already been done
- Create a strong but small regulatory body to regulate (not direct) the development of the sector by issuing licenses, prohibiting and penalizing anti-competitive behavior, regulating prices set by dominant providers, managing public assets such as the radio frequency spectrum, setting and enforcing technical standards so that all equipment is interoperable, and responding to consumer complaints
- Rapidly move to allow competition and private sector energies to enter segments of the telecommunication arena such as cellular phones, paging, leased lines, rural call boxes, voicemail, packet switched data services, and terminal equipment (phone sets and other customer premise equipment)
- Move to gradually reduce cross-subsidies from international traffic to long distance and local traffic, and from long distance to local traffic
- Gradually move to allow some competition in long distance and possibly in the "local loop" (local phone service), where such competition will not seriously harm the existing service provider
- Gradually move to privatize the major telecommunication provider (now usually a monopoly) by first creating a government-owned stock corporation, and second by selling a substantial part of the stock to a strategic investor (usually a foreign telephone company with substantial financial resources and technical expertise). The balance of the stock can be held by the government for future sale, as was done in the TELMEX privatization, sold to the public, sold at a discount to the employees, or some combination of the above.

Such a program will harness the entrepreneurial energies of the private sector; help to rapidly increase phone penetration, especially for businesses and industry; prod the existing monopoly provider into operating more efficiently; bring prices more in line with costs; and allow many new, small firms to flourish in the sector. Of course, local conditions may dictate a significantly different approach on occasion, but the general outline provided above should cover a majority of situations.

While a few countries have taken most or all of these steps (such as Malaysia, Chile, Argentina, Mexico, Venezuela, Britain, New Zealand, Australia and Canada); and some more are seriously planning to privatize (such as Hungary, the EC countries, Singapore and Thailand); most are discussing this course of action, commissioning studies, and taking only tentative steps. Given that there are only a limited number of strategic investors in the world and only a limited amount of investment funds, it would appear to be a classic buyers' market. This implies that those countries that are slowest to get to the table may be left with only the scraps. Since the countries that are moving the slowest to reform now appear to be the lowest income ones, this does not bode well for the future of the telecommunications gap between the rich/middle income countries versus the poor countries.

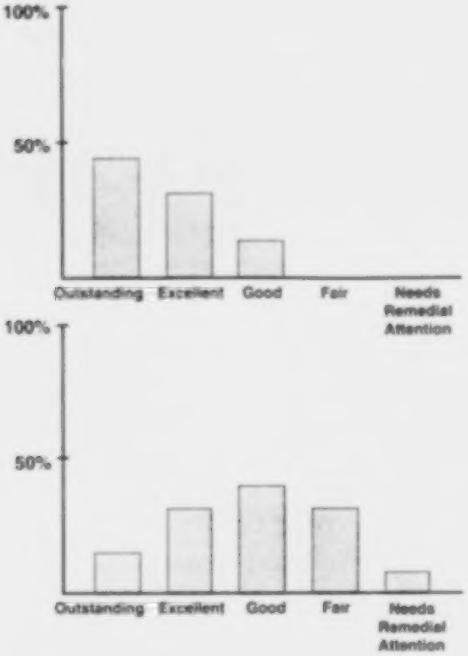
5. PERSONNEL, TRAINING AND ORGANIZATIONAL PROBLEMS

In 1984 the "Missing Link" report stated the following:

> Many problems over availability and quality of service in developing countries are symptoms of inadequacies in organization and management...Lack of sufficient trained staff is a major cause of the shortcomings of telecommunications in developing countries. Managers, supervisors and staff must be thoroughly trained. We recommend that developing countries review their training needs and resources...

Currently the situation in many less developed telecommunications organizations, both regulatory and operating, in the less developed countries and former Warsaw Pact, seems to have improved only a bit since 1984. Most such organizations still face tremendous personnel, training and organizational problems. These seem to have several causes:

FIGURE 7
PERFORMANCE APPRAISALS OFTEN ARE SKIPPED OR PROVIDE INADEQUATE ACCURATE FEEDBACK


Typical Distribution of Personnel Ratings in an Organization

Desirable Distribution of Personnel Ratings

FIGURE 8
PAY SYSTEMS OFTEN GIVE WORKERS LITTLE INCENTIVE TO PRODUCE

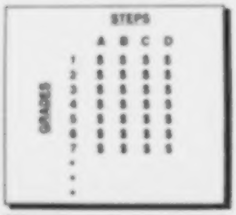
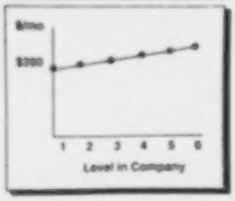
SYSTEM	CHARACTERISTICS	LOOKS LIKE
Civil Service-Style Pay System	• No Incentive to Work Hard • Often Leads to Bureaucratic Focus on PDs • "Make-Work" or Paperwork Focused	
Command-Economy-Style Pay Systems	• No Incentive to Work Hard • "We Pretend to Work and They Pretend to Pay Us" • Leads to Second Jobs and Conflicts of Interest • Production Focused, but Often Produce the Wrong Thing to Meet Monthly Quota	
Ideal Pay System:	• Gives Incentives and Disincentives • Rewards Teamwork and Individual Effort • Is Tied to Company Goals • Production-Focused	Bonuses + Base Pay

FIGURE 9
BOOZ·ALLEN OFTEN SUGGESTS A SYSTEM THAT COMBINES INDIVIDUAL AND TEAM PERFORMANCE BONUSES

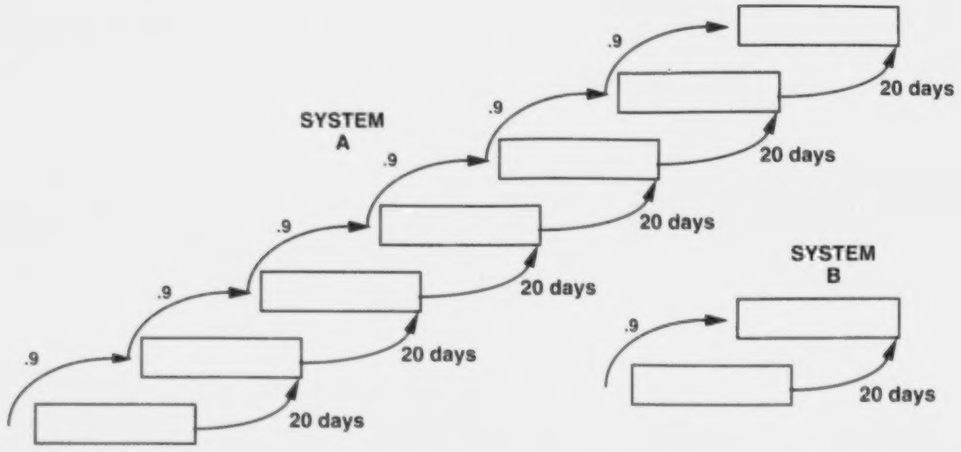
NOTIONAL

Individual Performance Rating	A = 15% B = 10% C = 5% D = 0% E = 0% and remedial action	Up to 15% of Total Salary
Plus		
Regional Team Quality and Quantity Performance	• Scores on 5 Key Quality Measures • Key Measures of Team/Area Production • Standard Award Decided By Management	Up to 15% of Total Salary
Plus		
Base Pay	Related to Measure of Level in Company, Level of Responsibility, and Technical Skill	Up to 70% of Total Salary
Equals		
Total Yearly Salary		100%

FIGURE 10
BENEFITS MAY EXCEED OR BE LESS THAN THE MARKET

	THAILAND		INDONESIA	
BENEFITS	TOT	PRIVATE	MTPT	PRIVATE
"Extra Months" Bonuses	Usually 2 – 3 Months	?	Sometimes 1 Month	Always 1 Month
Retirement Lump Sum Payment and Other Payments	Last Monthly Salary X yrs of Service; No Other Pays	Employer Matches Employee Savings Up to 5% of Salary	25% of Final Pay For Life	25% of Final Pay For Life
Health Care	Go to TOT Doctors or get 100% Reimbursement, Extended Family Coverage	100% Reimbursement but No Extended Family Coverage	Go to Free Designated Doctor or Hospital	Reimbursed 100% at Doctor of Own Choice
Vacation	NA	NA	14 Days/Year	14 plus Days/Year
Education Leave	Pays Full Salary	None	None	None
Low Interest Loans	4.5% Below Market	1% Below Market	None	None

FIGURE 11
THREE TYPICAL PROBLEMS OF OVERCENTRALIZATION


SYSTEM A
.9
.9
.9
.9
.9
.9
20 days
20 days
20 days
20 days
20 days
20 days
SYSTEM B
.9
20 days

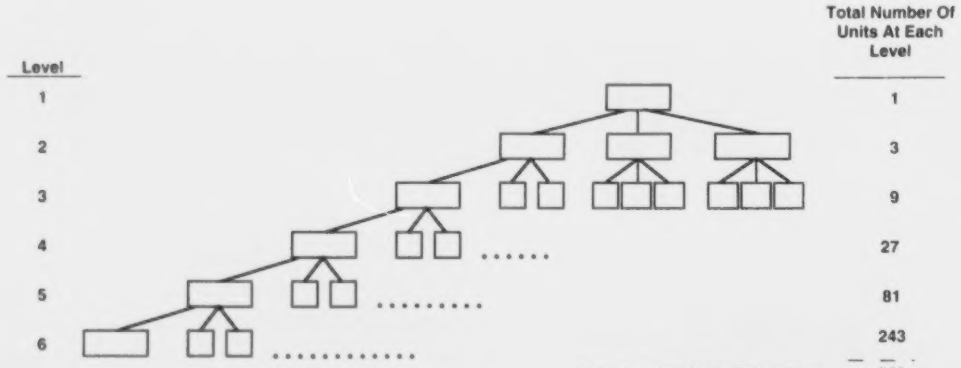
PROBLEM 1

Probably of Approval. Administrative system A requires 6 approvals to allow an action. Each approval has a probability of "yes" of 0.90 but the total probability that an action will be approved is only 0.53. This contrasts with administrative system B, where the probability of action is 0.90.

PROBLEM 2

Speed of Response. Each approval in administrative system A takes 20 days on average. Thus the total average approval time is 120 days. By contrast system B takes 20 days to respond.

FIGURE 12
THE THIRD PROBLEM WITH OVERCENTRALIZATION INVOLVES OVERLOADING SENIOR MANAGERS WITH TRIVIAL DECISIONS


Level
1
2
3
4
5
6
Total Number Of Units At Each Level
1
3
9
27
81
243

Total Number Units Below Top: 363
Approvals Per Day: x2
726
Minutes Per Approval: x30
21780
Minutes Per hour: 60
Hours/Day of Approval: =363

PROBLEM 3: Overload of Top Management. Assume a system with 6 levels and 3 subordinate units per each superior unit. Also assume that each subordinate unit originates 2 requests/day for approval, each of which requires 30 minutes to OK, and each of which must be passed to the top level for final approval. Then the top person will be inundated with 363 hours/day of minor decisions to approve.

FIGURE 13
LATERAL COMMUNICATIONS ARE VITAL UNDER THE NEW, MORE INTERACTIVE SYSTEM

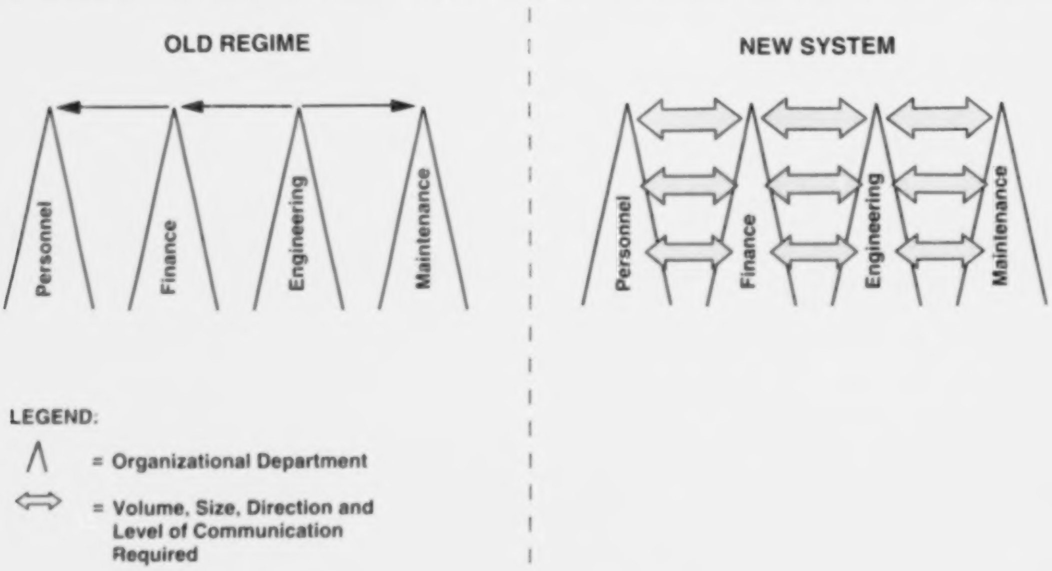
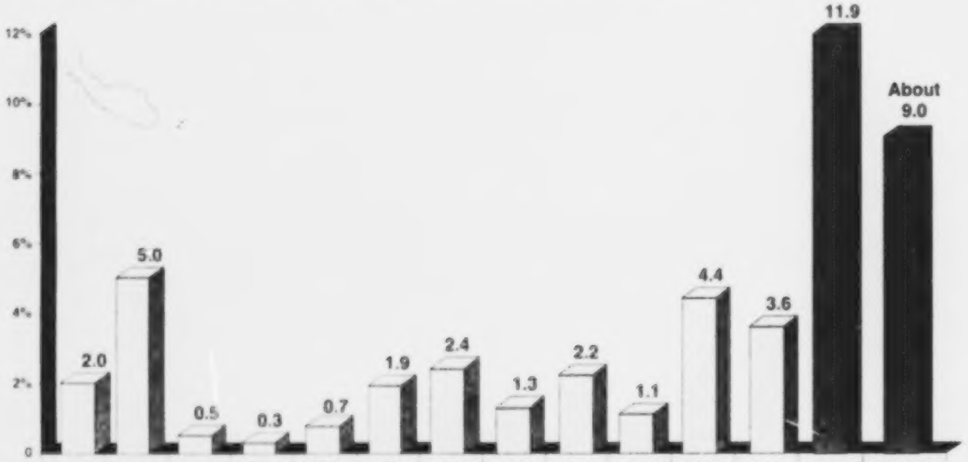

OLD REGIME
Personnel
Finance
Engineering
Maintenance
NEW SYSTEM
Personnel
Finance
Engineering
Maintenance
LEGEND:
= Organizational Department
= Volume, Size, Direction and Level of Communication Required

FIGURE 14
THE USUAL TRAINING PROBLEM IS THE LOW "TRAINING RATE"



Country (and date)	Indonesia PT Telkom (1992)	Indonesia PT Telkom (1995 Planned)	Uruguay (1991)	Poland (1991)	Czech (1993)	TOT Thailand (1989)	TOT Thailand (1992)	CAT Thailand (1989)	Taiwan (1992)	Colombia (EMCALI) (1992)	Gambia (Gamtel) (1992)	Oman (GTO) (1992)	Bell Atlantic (1992)	Booz Allen Recommended Rate
Number in Workforce:	44,541	56,301	8,100	65,000	25,000	18,200	18,200	21,000	38,000	1,500	450	3,000	210,000	
In training on typical day in training center(s):	N/A	N/A	48	224	160	300	375	370	N/A	15	10	60	15,000	6%
In external training:	N/A	N/A	2	1	12	50	50	10	N/A	2	10	50	10,000	3%
TOTAL:	890	2,815	50	225	172	350	425	380	800	17	20	110	25,000	9%

*"Training rate": the percent of employees in a workforce in training on a typical day.

**Includes 3,750 in external training and 6,250 in seminars, workshops, etc.

of training rates are very low indeed. If excess staff are to be "carried" for a while and trained to do the tasks required in the future, and essential staff are to be trained in their new duties, a huge investment in training infrastructure will be required.

As mentioned earlier, there is often little or no training available in the developing telcos in the "soft" areas such as personnel management, financial analysis, corporate planning, customer orientation, etc. Figure 15 shows the typical training needs in these areas.

Labor Relations

Telecommunication labor unions in such countries as Thailand, Colombia and Uruguay have successfully derailed privatization and restructuring plans. Their concerns need to be analyzed and "packages" of proposals devised to address their legitimate concerns. In telecommunications and other sectors, poor labor relations have probably derailed more privatization and restructuring plans than any other factor. Often part of the problem is that management has done little or nothing to develop and communicate a "vision of the future of telecommunications" to the employees and the public. In many organizations the top-down communications are worse than the lateral communications. In one middle-income country a study showed that 60 percent of telephone company employees' information about the telephone company came from the public press (not from management), and that most of the press information came from the telecommunication unions, not from management.

In the former Communist countries labor unions were once puppets of management (in fact one way to rise to top management was to become a labor leader!). But under the new realities, with poor economic conditions and possible privatization and layoffs in the near future, some telecommunication labor unions are starting to act like "real" Western-style unions. Again, what is needed here is management vision, communication of that vision to workers and union members, and careful design of restructuring plans to address legitimate worker concerns.

Staff vs. Line Capacity

A final typical personnel and organizational problem faced by many developing telecommunication organizations is a lack of "staff" as opposed to "line" capacity (see Figure 16). Often the functions of marketing, human resource development, legal and regulatory affairs, financial analysis and forecasting, public and consumer relations, and corporate strategic planning are absent or are very weak and need strengthening.

6. SUMMARY

In summary, telecommunications regulatory and operating entities in less developed and post-Communist countries have all the needs for institutional strengthening—manpower planning, training, personnel management, pay and benefits, overcentralization, internal communications, labor relations—that are common to other LDC governmental and quasi-governmental institutions. In addition, to serve as an aid to economic development, the telecommunication sector will need tremendous levels of investment in network expansion, and dramatic changes in sector liberalization, regulation and privatization. It seems unlikely that all countries will understand these needs simultaneously, or that the funds will be available to finance all the changes needed. Those countries that act quickly and "seize the day" will have a significant competitive advantage in the race for economic development.

In 1984 the Maitland "Missing Link" report said that, "An expanded telecommunications network will make the world a better and a safer place." If the challenges of investment, regulation and personnel are successfully met, perhaps this clear and attractive vision of the future can be realized.

FIGURE 15
ANOTHER KEY PROBLEM IS OFTEN THE LACK OF MANAGEMENT AND "SOFT" TRAINING

Typical Course Needs

CUSTOMER ORIENTATION

- Market Research Skills
- Sales Techniques
- Customer Relations
- Ethics in Business
- Product Development & Life Cycle

CORPORATE MANAGEMENT

- Project Management
- Contractor Supervision
- Management Analysis
- Strategic Planning
- Business Development

SYSTEMS

- Introduction to Computers
- Management Information Systems
- Operations Support Systems
- Decision Information Systems

ECONOMIC ISSUES

- Financial Forecasting
- Regulatory Economics
- Profit Center Management
- Budget Analysis

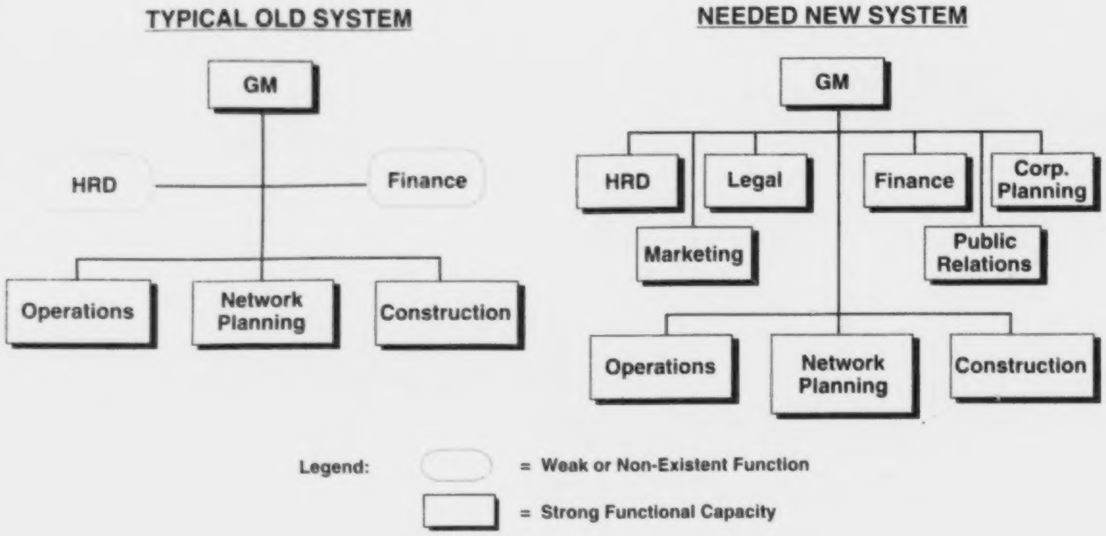
LANGUAGE SKILLS

- Technical English
- English for Operators
- Advanced English
- Other Foreign Languages

PERSONNEL

- Front Line Supervision
- Middle Management Supervision
- Senior Level Leadership and Supervision
- Labor Relations
- Training Program Development

FIGURE 16
A LACK OF "STAFF" (VS. "LINE") CAPACITY IS OFTEN A PROBLEM


TYPICAL OLD SYSTEM
GM
HRD
Finance
Operations
Network Planning
Construction
NEEDED NEW SYSTEM
GM
HRD
Legal
Finance
Corp. Planning
Marketing
Public Relations
Operations
Network Planning
Construction
Legend:
= Weak or Non-Existent Function
= Strong Functional Capacity

REFERENCES

[1] Dr. Timothy Nulty, "Emerging Trends in Telecommunications Policy in Developing Countries," Second Annual East-West Telecommunications Forum, June 1992. The Wall Street Journal Europe.

[2] Stefan Zehle, Prodata, ibid.

[3] See various essays by Bjorn Willenius, Peter Stern, Timothy Nulty, and Richard Stern, *Restructuring and Managing the Telecommunications Sector*, 1989, World Bank.

BIOGRAPHICAL INFORMATION

Llewellyn "Lew" Toulmin, Ph.D. is a Senior Associate at Booz·Allen & Hamilton. He has undertaken telecommunication regulatory, privatization, organizational and personnel work in Thailand, Indonesia, Poland, Hungary, Czech Republic, and Uruguay, and has trained telecommunication regulators and operators from all over the world in these topics. He has 21 years of management analysis experience, and has an M.P.A. from the Maxwell School of Syracuse University and a Ph.D. in policy analysis and economics from The American University.

DOING TELECOMMUNICATIONS BUSINESS IN DEVELOPING COUNTRIES
THE LEGAL ISSUES

Jane Levine, Allen Allen & Hemsley, Sydney, Australia

1. ABSTRACT

This paper briefly addresses the legal and commercial issues facing private investors and developing countries in connection with development of telecommunications infrastructure.

2. INTRODUCTION: TELECOMMUNICATIONS OPPORTUNITIES IN THE ASIA - PACIFIC REGION

Telecommunications development throughout the Asia-Pacific region has been most uneven. For example, Indonesia with a population of 182.5 million has less than one main telephone line per 100 people. In contrast Japan has 124 million people, a teledensity of 42 main lines per 100, and is moving towards development of a sophisticated Broadband Integrated Services Digital Network (B-ISDN).

Yet opportunities for growth in the development of telecommunications infrastructure region are significant.

The Asia-Pacific region is a high growth area and the only world region showing an increased share of global GDP up to 1995. The newly industrialised economies (South Korea, Taiwan, Singapore and Hong Kong) and the six ASEAN economies are forecast to grow on average almost 7% during 1993, according to Japan's Institute of Developing Economics. Although such forecasts depend on the performance of Japan, being the region's main source of investment capital and the largest market, increased public investment on infrastructure, direct foreign investment and increased exports are all seen as contributing to these performance predictions.

James Martin Strategy, a US consultancy firm, estimates that the Asia-Pacific telecommunications market will exceed $US100 billion in the next five years as a result of growing international trade and investment and an evolving regional network of trade relationships. Another 1990 study by US consultants, SRI International, predicts a 6% growth rate in telecommunications capacity (measured in access lines per capita), with China, Thailand, Indonesia and Malaysia growing at between 10-17%. Further, a compound regional growth rate of almost 10% will see total expenditure on telecommunications products and services to increase from $US113 billion in 1990 to $US178 billion in 1995.

With such significant opportunities, it is important that both telecommunications suppliers and developing countries maximise the likelihood of successful development of telecommunications projects by understanding one another's needs and taking steps to build on-going relationships. The following paper examines some legal mechanisms that might be utilised to achieve successful business relationships.

3. TELECOMMUNICATIONS INVESTMENT - THE NEED FOR CONTINUOUS AND GROWING PRIVATE INVESTMENT IN DEVELOPING COUNTRIES

At a global level there have been recent changes in the accepted telecommunications regulatory norm. Prior to 1987-1988 although most countries throughout the world had either a Ministry department monopoly or a State owned corporation formed from the Ministry department, the first steps towards widespread privatisation were being taken. Following the US, the UK and Japan introduced rapid changes with the introduction of both private investment and competition. A regional trend in Asia-Pacific towards partial privatisation and liberalisation was and is increasingly evident, with virtually every nation restructuring its industry to accelerate network development, accommodate new technologies, and respond to an increasingly regional and open market place. The traditional view that telecommunications cannot be entrusted to the private sector, and far less to the foreign investor, is being challenged in many developing and industrialised countries in the region and in the world in general.

The crucial need for private and/or foreign involvement in telecommunications investment results from the different nature of telecommunications generally. Unlike many manufacturing and infrastructure investments such as highways, electricity, water treatment, bridges which require largely 'up front' investment, telecommunications demands a continuing and, usually, growing level of investment year by year.

These two factors, namely, changing perceptions as to the need to maintain strategic Government telecommunications monopolies and the different nature of telecommunications investment itself have been accompanied by the realisation that there is a need to maintain technological advancement in telecommunications which simply cannot be met by the public purse. It is likely that governments will be forced to look to the private sector for funding. And as far as many Asia-Pacific countries are concerned, only foreign telecommunications operators will have sufficient funding capacity. Moreover, foreign operators are the only parties likely to have access to essential technology and committed management experience.

If involvement of foreign investors is considered essential, it is crucial that a return for investors be maintained for each stage of technological development. New technology improvement will not occur unless there is such a promise of investment returns, and those returns should come to investors sooner rather than later. Governments should therefore appreciate the need for investors, and particularly foreign investors, to have adequate legal mechanisms to protect their investment.

At the same time, foreign investors must appreciate that governments, for strategic and political reasons, may require control over telecommunications infrastructure and on-going flexibility in deciding whether they wish to continue to deal with the foreign investor.

In these circumstances, the parties must have a mechanism to bring the relationship to an early, but amicable end.

4. LEGAL CONSIDERATIONS

Most Asia-Pacific countries now seeking the benefits of telecommunications privatisation have in place laws allowing only the Government to provide service to the public. Privatisation will normally require changes to the law, even where the Government has a majority shareholding in the privatisation vehicle. This re-regulation can be a difficult exercise, but it may be essential in order to ensure that privatisation can succeed and to ensure adequate protection for any foreign investor.

The part played by legal documentation in order to protect the interests of both Government and investor is crucial. The object of legal documentation for the ordinary build, operate or transfer ("BOT") telecommunications project will be:

1. to record the agreements with investors and lenders as to return on, and the repayment and duration of, their respective financial commitments and the assumptions on which such agreements are based;

2. to allocate, as between the parties to the joint venture or BOT project, the risks attaching to changes in circumstances which may affect the security concerns of governments and the returns to investors or lenders; and

3. to insulate, to the extent commercially practicable, the returns to investors and lenders from such changes in political circumstances, while ensuring adequate flexibility and control of projects for governments.

The legal framework of a joint venture or BOT project must deal with two broad categories of legal considerations:

1. It must establish joint venture arrangements, or concession arrangements in the case of a BOT, with the government, which are binding on the government, are binding on third parties and reflect the underlying commercial agreement; and.

2. It must also establish contractual arrangements with other parties to the joint venture or BOT project - contractors, managers, suppliers and financiers - which, consistent with the joint venture or concession arrangements, reflect the underlying commercial agreement.

4.1 Dealing with Governments

All governments to a greater or lesser extent are affected by political considerations in making privatisation decisions. This applies to the commencement of projects and to subsequent events which arise during the course of a project. The net result is that one should not assume that a Government or Government entity will always be able or willing to continué with contractual obligations promptly, or indeed at all.

Investors are aware of this exposure and, for obvious reasons, may not be prepared to accept loose contracts including the following sorts of terms:

1. grace periods for payments by the government;

2. "if in the reasonable opinion of the government" style of clauses;

3. soft ambiguous phrases dealing with important issues; and

4. provisions allowing the Government to set off payment obligations against moneys due to it from the joint venture or BOT project.

If a Government wishes to preserve its flexibility to terminate a project in future, it must ensure that the foreign investor will be given an adequate return for work performed and investment made. Otherwise, the supplier may simply choose not to invest, or will exercise its rights to suspend supply or development of a telecommunications network in the event of a dispute with the government. For example, the foreign company may simply suspend network rollout in the event of the Government failing to meet its obligations under the joint venture or BOT arrangement. Suspension of supply may not be in the Government's interest.

A joint venture or BOT project would normally expect to receive a legal opinion from the government's legal advisers that the Government has authority to enter into the agreement and will be bound by the agreement. The legal systems of many Asian countries (and developing and newly developed countries everywhere) may not be adequate for the needs of many foreign telecommunications investors so therefore one might query the point of such an exercise. However, foreign investors will require some comfort that the Government will not construct spurious legal grounds for a politically driven attempt to renege on the project. If the Government is unwilling to "guarantee" the project, this flexibility may require the Government to make large guaranteed up-front payments to the foreign investor in the nature of performance guarantees.

Some additional and more specific legal issues to be addressed include the following:

(a) Dispute Resolution

The joint venture or BOT agreement should contain detailed dispute resolution mechanisms which, at the very least, are not unfavourable to the foreign telecommunications company. Consideration will have to be given to the proper law of the joint venture or BOT concession arrangements and the tribunal in which the disputes between the Government and the foreign company are to be resolved. It therefore follows that any dispute between the Government and the foreign company in which the Government is in the wrong should entail an obligation on the government's part, recognised by a court or arbitral tribunal, to compensate the foreign company. Most governments are subject to a variety of constitutional constraints as to when, for what purposes and in what manner Government moneys can be paid out. The joint venture agreement or BOT concession arrangement should, if possible, obtain (or be designed in such a way as to fit in with existing provisions for) all necessary internal Government approvals in order to satisfy judgments or awards against the Government in respect of suitable compensation claims.

The foreign investor is likely to be more comfortable if dispute resolution is taken away from the national courts of the country concerned and placed with an international court or commercial arbitration tribunal which is acceptable to the Government. However, the practicality of such a measure depends on the political climate and on the treaty arrangements, (both as to submission and recognition of foreign awards) applicable in any given case.

It may be possible to have a foreign arbitrator, with the dispute being dealt with in the developing country, and with the arbitrator applying international procedural rules.

(b) Performance, Delivery and Payment Arrangements

The scope of the work to be performed by the foreign telecommunications company must be very carefully defined in order for Government to have a measurement against which to test performance and, from the investor's standpoint, in order for the transaction to remain profitable. Legal documentation for the project should state clearly that additional work requires additional pay and should set forth explicitly the performance which must be rendered in order to receive payment.

To provide certainty for the benefit of both parties, legal documentation should also do the following:

1. Specify performance deadlines and when payments are due and provide interest or penalties for late payments and liquidated damages for late performance;
2. Strike a balance between up-front, lump sum payments and on-going payments. The *quid pro quo* for a Government having the right to arbitrarily terminate the arrangement at some future point is likely to be a larger up-front payment as well as a payment schedule which keeps the cash-flow positive throughout the project and indexes or otherwise adjusts future payments for inflation;
3. Describe all permissible withholdings such as taxes, social security, retentions, and provide that no other withholdings may be made without prior approval. Investors may require performance bonds or stand-by letters of credit to retention of money at the end of the contract;
4. Carefully spell out the payment mechanism and consider whether irrevocable letters of credit should be established at the beginning of the venture;
5. In the event that approval of invoices is required prior to payment, stipulate what the approval mechanism is and provide that approval is deemed given unless specifically denied in writing within a specified period after submission;
6. A foreign investor may require payment in hard currency to avoid the effects of foreign exchange fluctuations. If hard currency is not available, the parties may need to consider hedging arrangements;
7. Anticipate future changes in regulations dealing with repatriation of profits, royalties, and other forms of return on investment from the venture. Investors are likely to pressure for hard currency deposits in off-shore accounts or letters of credit payable in hard currency as a useful precaution;
8. Both parties may need to consider whether insurance coverage should be purchased against extreme restrictions on convertibility of local currency; and
9. Ensure that unfair local administration will not apply (by, for example, including local taxes as reimbursable costs for the operator).

(c) General Provisions

The following general provisions are fundamental to any joint venture or BOT concession arrangement between foreign investor and a government:

1. a clear and unequivocal right to conduct the project, usually to the exclusion of local and other foreign competitors. No investor or lender will provide funds without this;
2. a clear description of the scope of the project and of ownership rights in technology associated with the project. The initial scope of the project should be

clear, since if the Government changes its' mind as to what it wants, this may affect the cost of or return from the project;

3. a clear minimum period for the joint venture or the BOT concession. If the Government can shorten the joint venture or concession period unilaterally without compensation, this will affect the return from the project and make the project unattractive from investor's standpoint;
4. protection against conflicting third party rights, claims, or infringements;
5. a commitment by the Government to use relevant governmental powers in support of the project. For example, the Government should undertake to effect compulsory acquisition of land necessary for the project; or make available sufficient radio frequency spectrum;
6. a commitment by the Government to facilitate Government action in relation to the project. For example, the joint venture or BOT concession company may require various inter-departmental committees to be set up so as to co-ordinate Government action, or Government assistance may be necessary to negotiate international interconnect or settlement arrangements which are crucial to a telecommunications venture;
7. a clear statement of the extent to which and the circumstances under which the Government, or its instrumentalities, will be entitled to interfere in the construction or operation of the project;
8. a commitment of financial non-interference. The joint venture or BOT concession arrangements should make provision so as to guarantee to the foreign investor the fiscal treatment and appropriate rights to remit revenue and profits, as this will be the basis on which the project will be financed;
9. a commitment to accept risk. Risks which, commercially, should fall on the Government should be accepted by the Government under the concession agreements. In the absence of mutual risk-sharing, the foreign investor will be driven to walk away or to considerably increase the price.
10. compensation provisions. The joint venture or BOT concession arrangements must make provision for appropriate compensation to the foreign company in return for the Government receiving a right to terminate or compulsorily acquire the project, or in the event of any failure of the Government to comply with its other obligations under the joint venture or BOT concession arrangements (if this has a financial effect on the project); and
11. loan enforcement. More favourable financing arrangements may be obtained if the joint venture or BOT concession arrangements allow the project lenders to take over management (of the joint venture or foreign BOT concession company) and the project in the event of a financial default by the foreign company, without triggering termination of the joint venture or BOT concession.

The importance of dispute resolution mechanisms, outlined above, cannot be over emphasised. Governments legitimately object to restrictions on their freedom of action. National circumstances change and in order to do their jobs properly, governments have to adapt to such changes. Therefore in joint venture or BOT concession arrangements it is usually better to attempt to predict possible Government actions which may be taken and which may be adverse to the foreign operator and provide for Government compensation for the financial consequences, rather than to attempt to limit the government's freedom of action. For example, it might be better for the joint venture or BOT concession arrangements not to provide that the Government will not nationalise the project. Rather, the agreement should say that if the Government does nationalise the project, it will pay compensation according to a predetermined formula. An express promise to pay damages is a mutually satisfactory outcome. The investor has its return. The Government has preserved its independence and is less likely to attract adverse foreign reaction if it chooses to terminate, avoiding a result which discourages future foreign lending and investment.

4.2 Shareholder Arrangements

Often it is the case that a joint venture company or other entity will be formed between the Government and the foreign telecommunications operator. However, the arrangements between the parties in relation to a joint venture company can sometimes be overlooked. To avoid problems, the details of the joint venture should be the subject of an agreement which addresses the following issues:

1. amounts and timing of shareholder capital contributions;
2. security (for example, letters of credit and bank guarantees) to be provided for any deferred capital contributions;
3. dividend policies and payments;
4. returns of capital;
5. restrictions on disposal of shares by shareholders;
6. composition and powers of the board of directors and mechanisms for handling the day to day business of the joint venture;

7. the appointment of financial, accounting, legal and other advisors to the joint venture entity;

8. issues on which the joint venture entity cannot act without unanimous (or special majority) approval of the directors or shareholders;

9. access to company information and financial records of the joint venture;

10. confidentiality;

11. ownership of joint venture property, particularly jointly developed technology; and

12. a "divorce" procedure in the event that one or all of the parties wish to terminate participation.

4.3 Financing Arrangements

Any debt financing associated with a joint venture or BOT project is likely to be on a limited recourse basis. That is to say, the lenders will have no security over any property and no right of recourse against any other person in respect of principal or interest other than the project itself. Limited recourse may be established by the simple fact of the joint venture company or BOT company being a single project company whose shareholders give no guarantees of its liabilities. It may also be established by a complicated series of contractual arrangements, the purpose and effect of which is to limit recourse as noted above.

In addition to the normal issues to be dealt with in respect of any financing, major issues will include the right of the lenders to take over the project upon default, the degree of control to be exercised by the lenders over the day to day management of the project and the extent to which non-compliance by the Government with its obligations under the joint venture or BOT contract will give rise to default under the loan agreement.

This latter point illustrates the need to look very carefully at financing arrangements. Many banks typically wish to be able to call a loan in the event of a termination of the joint venture or BOT arrangements with the Government or in the event of a default under the arrangements. The net result is to put the foreign telecommunications party in a position where it is fighting on two fronts in the event of a genuine dispute with the government. On the one hand, it is fighting the government. On the other, it is looking over its shoulder at its lenders who, in many countries and particularly where domestic funding is involved, will be hand in hand with or even owned by the government. Thus it is vital to formulate financing arrangements that will avoid the situation where the foreign company finds itself caught in a pincer.

5. TOTAL OUTSOURCING OR TOTAL GOVERNMENT CONTROL

5.1 Outsourcing of Operations: Privatisation

From the point of view of a foreign telecommunications operator, full privatisation is clearly the best outcome. The foreign operator is fully motivated to reinvest for commercial reasons and needs to perform well enough to secure licence renewal. Full privatisation also has benefits for the developing country as it provides the means to avoid technical obsolescence, to encourage foreign investment and to bring about long-term investor commitment. However, from the point of view of the Government full privatisation may be a fairly bold step, leaving it only with regulatory control over the operation. From a political standpoint it is likely that a joint venture between the Government and the foreign operator will be the preferred option.

5.2 Shifting Towards Government Control

A Government takeover of telecommunications assets may occur through a BOT or build, transfer and operate ("BTO") concession agreement, or through nationalisation of foreign built telecommunications infrastructure by the government. Even if a Government is sincere in making an initial commitment not to nationalise telecommunications assets, this possibility cannot be overlooked as circumstances for the Government may change in future. It is better, therefore, for the issue to be covered in legal documentation for a joint venture between the Government and the foreign telecommunications investor.

Both BOT and BTO concession arrangements may be less satisfactory (as compared to a joint venture) from the point of view of foreign operators and governments if the goal is to secure ongoing investment and state-of-the-art technology. For a BOT, revenue from the operation is used to pay for specific equipment which will be provided as quickly as possible to maximise revenue during the fixed operating period. In this respect the BOT concession is advantageous to the foreign telecommunications operator in that maximum return is obtained on an upfront basis. The operator has no real interest in what happens after its operating period and so a BOT concession arrangement is not a good means for the Government to ensure ongoing investment, avoid technical obsolescence and accommodate changing socio-economic needs. While the Government may eventually receive equipment and network facilities without payment these are usually obsolete or approaching obsolescence by the time Government take-over occurs.

In terms of achieving the goals of ease of regulatory transition, maintaining Government day-to-day control and guaranteeing national security, a BTO concession arrangement is superior to that of a BOT. However, in terms of the investment and technology goals previously mentioned, the BTO is an inferior vehicle when compared to a joint venture or

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fully privatised operation. The BTO also presents additional accounting and legal problems for many foreign telecommunications operators. The telecommunications assets are transferred to the Government at once, before operations start. The foreign operator then has on its books a right to use the assets rather than title to them. In practical terms this may lead to the same result for the operator. However, BTO concessions may sometimes impose restrictions on the freedom of investment decisions by the foreign operator, making the relationship between investor and Government more like an equipment and network supply contract with long-term, high risk financing. In the foreign telecommunication operator's country of origin, some legal gymnastics and creative accounting are needed to record for posterity, and more particularly for the shareholders, what the company got for its money. (On the question of forms of privatisation, see generally, John Slaughter "Joint Venture or BOT: the Choice for Telecommunications Development with Foreign Involvement" Pacific Telecommunications Council 14th Annual Conference: Proceedings Papers January 1992.)

6. OTHER ISSUES

6.1 Taxation

The foreign telecommunications operator needs to examine the laws relating to taxation in the developing country. In particular, the foreign operator should examine the general level and structure of corporate taxation in the host country and any taxation treaties between it and the foreign operator's country of origin. Another issue to be considered is whether taxation payable by the foreign telecommunications operator should be set-off against payments due to it by the Government although, as outlined above, it is probably better for the foreign operator to receive moneys owing to it by the Government and then worry about paying taxation later. Otherwise the risk to the investor may be that the Government raises claims as to the taxation liability of the foreign company in order to reduce the payment obligations of the government.

6.2 Intellectual Property

To secure adequate levels of telecommunications investment and provision of state-of-the-art technology, it will be necessary for the Government to convince the investor that it has adequate laws and forums for the protection of intellectual property which exists in the operator's equipment, technical methods and expertise.

7. CONCLUSION

There are significant telecommunications opportunities in Asia. However the foreign telecommunications company must be careful when pursuing investment in the region, particularly when entering into a joint venture or otherwise dealing with governments. It is important that any arrangement with a Government contains the measures outlined above to protect foreign telecommunications investments. If investor protection is achieved in this way, then in the long run Asian governments and telecommunications users will benefit through increased investment in telecommunications by foreign and domestic telecommunications operators who can be confident that their investment is being protected and that an adequate return is being made.

If a Government is sensitive to a foreign investor's needs for certainty of return and adequate protection of technology and if the investor is sensitive to the government's likely need for flexibility and sovereignty, then it should be possible for both parties to enter into mutually beneficial arrangements to provide better telecommunications infrastructure and increased investment opportunities. To achieve such an outcome, however, the parties should effectively document their objectives (by dealing with the issues raised in Parts 3 - 5 of the paper) and provide for a mutually acceptable termination.

TELECOMPUCATIONS
A Convergence of *Telecommunications* and *Computations* For Developing Nations

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1. ABSTRACT

In this paper we focus on the interplay between the technological frontiers of two dramatic forces (communicating and computing) in our society. We integrate these trends to investigate telecommunication, computing, and intelligent systems and networks of the nineties. We then refocus these technological developments and the trends in facilitating the planning and migration (or perhaps leapfrogging) of the Developing Economies into the modern Telecompucations Arena.

2. INTRODUCTION

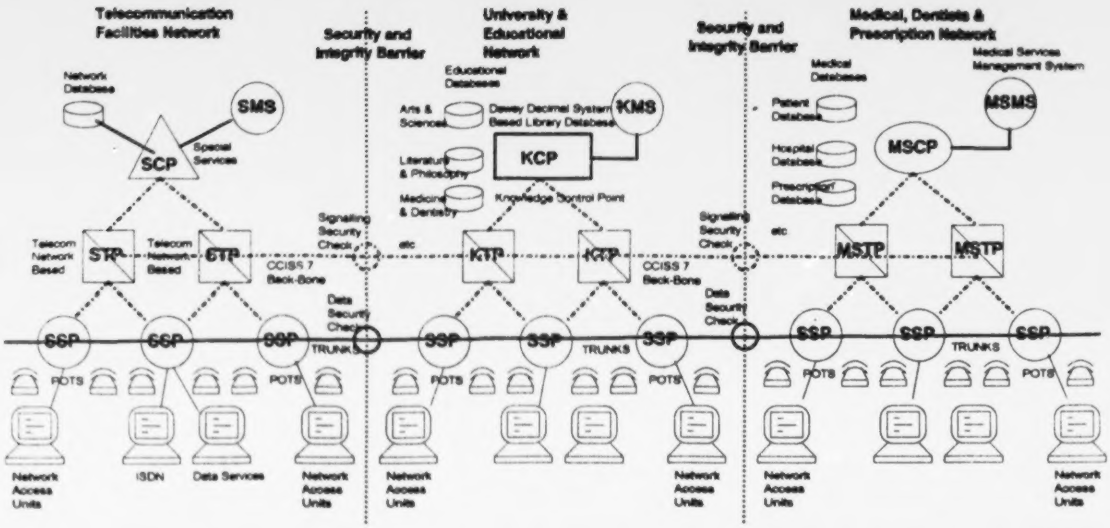
Proper integration of the two forceful disciplines (computation and communication) in the seminal stages of design and development of a new breed of specialized networks can save the developing countries enormous expense and delays in bringing home the new features and services. Such features are intended to serve the educational and social needs of the host countries. In a peaceful global environment, the human, technological, and financial resources can be focused to the needs of individual countries. Progress in new directions, can now be made by forging new links between technologies of the nineties and the most basic of human needs: the need to communicate with anybody, at any time and at any place.

Such goals are in the realm of modern communication systems that rely heavily on the embedded computer based switching systems. These objectives have been largely achieved in the Western hemisphere. However it is our contention that with very slight effort, educating the peoples of the third world countries, and serving their medical needs can be viewed as a necessary functions of the evolving Telecompucation network. These networks become specialized to suit the geographic, demographic, socio-cultural (including educational and medical), and communication needs of the particular developing country. When the back-bone network is not in place, the enhanced signaling functions to perform the specially tailored extra functions of the network can be built into the back-bone network. When the back-bone network is in place, the enhancements need to be incorporated into the existing network. Compatibility and integration of the old and new functions become the crucial problem for the network designers. However, with the stored program control of the switching systems, presently embedded in most networks, the problem is manageable and has fairly standard approaches to the solution. From the perspective of the network specialist, forging new links between technology and social needs is not a problem but simply a project. However, such network-specialty is rare, especially in developing countries. For this reason the problem for developing countries is that of coordination between the designing the architecture of these specialized networks and their final implementation. If the entire problem is entrusted to the commercial network designers, the price can become excessively high. Conversely, an ill-designed network is no network at all. The two extreme approaches to the problem have become important enough for most developed countries to establish high level Departments or ministries of telecommunications and we suggest that this is where the problem needs to be addressed.

3. PROPOSED ARCHITECTURE

The platform for the specialized telecompucational networks is that of basic intelligent networks (1,2,3). These basic intelligent networks are firmly established in most of the developed countries around the world and serve the specific needs of the network such as the 800, 900, 700, 911, ABS, CLASS, etc type of services. A variety of such networks are discussed in (4).

The enhancement of these basic intelligent networks, depends upon the needs and character of the specific country. In Fig. 1, we present the architectural modifications for the basic intelligent network (on the left side of the figure), designed to serve the telecommunication need, also to perform educational and medical services in that country. The network consists of the three networks with common signaling and trunk routes. When the demands of a specific country are not large, the separation of these networks may be logical rather than physical. Within the same basic building


Telecommunication Facilities Network
Security and Integrity Barrier
University & Educational Network
Security and Integrity Barrier
Medical, Dentists & Prescription Network
Network Database
SMS
SCP
Special Services
Educational Databases
Arts & Sciences
Literature & Philosophy
Medicine & Dentistry
Dewey Decimal System Based Library Database
KMS
KCP
Knowledge Control Point
Medical Databases
Patient Database
Hospital Database
Prescription Database
Medical Services Management System
MSMS
MSCP
Telecom Network Based
STP
Telecom Network Based
STP
CCISS 7 Back-Bone
Signalling Security Check
etc
KTP
KTP
CCISS 7 Back-Bone
Signalling Security Check
etc
MSTP
MSTP
Data Security Check
Data Security Check
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POTS
Network Access Units
ISDN
Data Services
Network Access Units
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Network Access Units

Figure 1. An architecture of a combined Telecommunication, Educational and Medical services Network with enhanced signalling capability and secure Trunk line barriers for the integrity of all three networks. SSP denotes Service Switching Points, STP denotes Signal Transfer Point, SCP denotes Service Control Point, and SMS denotes the Sevice Maintenance Systems. In the Educational and Medical network, the functionality of these units are modified to serve the particular function in that network.

blocks of the network, (i.e., the SSP, the STP, the SCP, and the SMS, with or without the intelligent peripherals and/or the Adjunct Processors) of these networks, logical software barriers may be introduced to facilitate the same hardware units to serve the Telecommunication functions or those of the educational or medical networks.

Hierarchically, the switching of the voice and data paths is confined to the subscriber and trunk lines. The appropriate signaling information is received from the SCP (or KCP, or MSCP) via the STP (or the KTP or the MSTP). The detailed functions of the KTP and KCP are outlined in Ref. 3. By extension of the functions embedded in network based educational systems (4), the functionality of medical network may be derived. In a sense, the concepts overlap but the implementation and the applications become different. Such differences are handled by the individual software modules in the SSP's.

4. CONCLUSIONS

The standardization of the signaling protocol, and the impact of Fiber, the availability of inexpensive hardware and the progression towards ATM make it necessary to reconsider the revitalization of the national networks of developing economies. Network Architecture for these countries has very special character and in this paper we have presented an architectural variation of the traditional intelligent network that can be implemented to accomplish a multiplicity of functions quite economically for most of these developing countries.

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MASS CALLING SERVICE

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1. ABSTRACT

Telecommunications customers are continually seeking higher quality and more diversified services, as well as the ability to use these services at lower cost. To remain competitive and still satisfy customer requirements, network operators must develop advanced services rapidly and efficiently while maintaining low cost and high reliability. Intelligent Network architecture is proposed to satisfy both customer and network operator requirements. This paper describes NTT's Intelligent Network structure and Mass Calling Service which is realized by employing a unique technology on the basis of its Intelligent Network architecture.

2. BACKGROUND

In the 1960's and 1970's, new services such as Three-Way Call and Call Forwarding were implemented by modifying hardware or software in local switches. This method had limitations as to how efficiently new services could be developed. As a variety of software sysytem increased, the development cost for new services increased rapidly. In addition, as more number of local switches were deployed, the cost of modifying all the switches required more manpower and more time to provide nationwide services.

A new implementation method was proposed to solve the above problems in the middle of 1970's. In this method, necessary functions were separated from local switches and integrated into a specific toll switch. New service calls are routed to the specific toll switch and processed by it. NTT has provided Credit Call Service, Facsimile Network Service, and other services by this method, which has considerably reduced the number of switches to be modified. However, new problems nevertheless arose. New circuits had to be established between all the local switches and the specific toll switch. In addition, optimum routing was not guaranteed because a new service call had to be routed to the specific toll switch regardless of its final destination.

In order to overcome these problems and pursue more efficient architecture for various future services, Intelligent Network architecture has been proposed and implemented. In this architecture, necessary functions to provide advanced services are separated from switching nodes and implemented in so-called intelligent nodes.

3. INTELLIGENT NETWORK ARCHITECTURE

It is very important to define fundamental network architecture clearly so that the Intelligent Network enables a network operator to provide advanced services efficiently throughout a nationwide area. Figure 1 shows NTT's Intelligent Network structure. There are two types of intelligent nodes: Network Service Support Point (NSSP) and Network Service control Point (NSP).

An NSSP contains a customer database and network management functions, and down-loads the customer data necessary for service processing to an NSP via an X.25 packet network. An NSP performs service analysis and control in real time.

On the other hand, switching systems and transmission links make up the transport layer. Group Center (GC) is a digital local switch and has a function of access to an NSP. When a specific service number is dialed, the GC sends

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the dialed number to the NSP to get the information necessary for connecting the call. The NSP translates the received number to determine, for example, the physical terminating number and charging method, and sends such information back to the GC. The GC then makes the connection based on the response from the NSP. A CCS No.7 network is used for these data transfers.

Thus, the necessary functions for new advanced services are integrated in NSPs and NSSPs. This new allocation of functions gives us much more freedom to develop new advanced services.

4. CREATION OF NEW SERVICES

Generally speaking, there are three major factors which define a service: numbering plan, connecting method, and charging. Therefore, new concepts introduced to these three factors can create new services. For example, if we use logical numbers as a numbering plan, we can then create Private Numbering Plan Service. If we utilize multi-connection, we can provide Mass Calling Service. Reverse charging can provide Free Dial Service and so on.

We can thus generate new service specifications by modifying existing service factors. In addition, we can come up with more new services by combining new service factors. The important point is whether or not we have the means to implement these new services efficiently and timely. An Intelligent Network can be a strong basis to enable us to do so.

5. MASS CALLING SERVICE

Recently, various telephone services combined with mass media have been provided by broadcasting stations and information providers, etc. This type of telephone service often arises traffic congestion in the telecommunications network since the plan is propagandized to the public through mass media like TV. In such a case, a network operator must restrict most of calls to the specific customer to prevent traffic congestion. Thus, a number of calls are terminated at the originating switch as busy tone treatment or congestion announcement treatment. These incomplete calls result in degrade of service to the originating customers and loss of profitable chances to a network operator.

Mass Calling Service has been developed to handle this much traffic and make all the calls completed instead of busy tone treatment. Mass Calling Service includes two different types of services: Multi-Connection Service and Telephone Voting Service.

5.1 MULTI-CONNECTION SERVICE

Some Information Providers(IP), who are also important telecommunications customers to NTT, want to provide their information to thousands of people simultaneously. If using the traditional connection method, an IP must subscribe to an extraordinary number of lines to handle thousands of simultaneous calls, which,

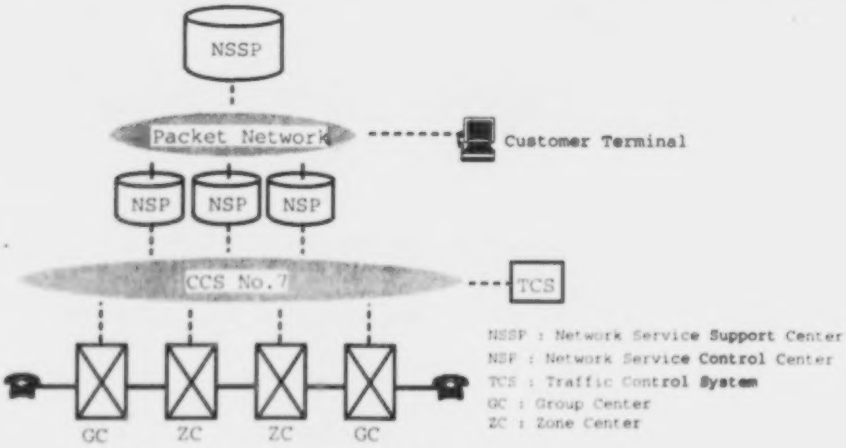

NSSP
Packet Network
Customer Terminal
NSP
NSP
NSP
CCS No.7
TCS
NSSP : Network Service Support Center
NSP : Network Service Control Center
TCS : Traffic Control System
GC : Group Center
ZC : Zone Center
GC
ZC
ZC
GC

Figure 1. INTELLIGENT NETWORK STRUCTURE

of course, is not practical. Congestion will also occur around the terminating switch.

In order to handle this much traffic, a new connection method called multi-connection has been developed. Figure 2 shows Multi-Connection Service and its unique connection method. For the first call, a connection is established to the terminating IP in the usual way. However, when the second call is generated while the first call is still in progress, the second call will be multi-connected at point A because the connection beyond point A has been already set. Similarly, the third call will be terminated at point B. Thus a call to the same IP will be terminated at the nearest point.

This method includes two major advantages. First, theoretically speaking, no terminating congestion will occur in providing the service to mass originating customers. Second, the cost of new circuits to convey traffic will be minimized. By using this method, an IP can provide the information to thousands of people at the same time with only one telephone line.

5.2 TELEPHONE VOTING SERVICE

Figure 3 describes Telephone Voting Service. In this service, a specific service number is assigned to each answer such as "Yes" and "No" in response to a particular question, for example, "Do you support the current Ministry?". Telephone users can vote either "Yes" or "No" by dialing the corresponding service number. The total number of votes can be collected in real-time and sent to a PC on the customer's premises. The network can count more than five-hundred-thousand calls within five minutes. This service will allow, for example, a TV program to ask a questionnaire of the public in prime time and show the results of voting at once.

Sometime, a TV program wants to know the reason for "Yes" or "No" from a voter. In such a case, Call Selection Service is available as an optional service. A network selects a certain number of calls at random from all the voted calls and connect them to the telephone lines prepared by the TV program in advance. This call is called "Through" call while a call just only counted is called "Cut" call.

In order to count thousands of calls in a short time, a new method of function allocation has been developed. As explained above, the necessary functions for new advanced services are usually allocated in intelligent nodes. However, this type of function allocation faces a problem in dealing with mass traffic. When mass traffic is generated almost simultaneously,

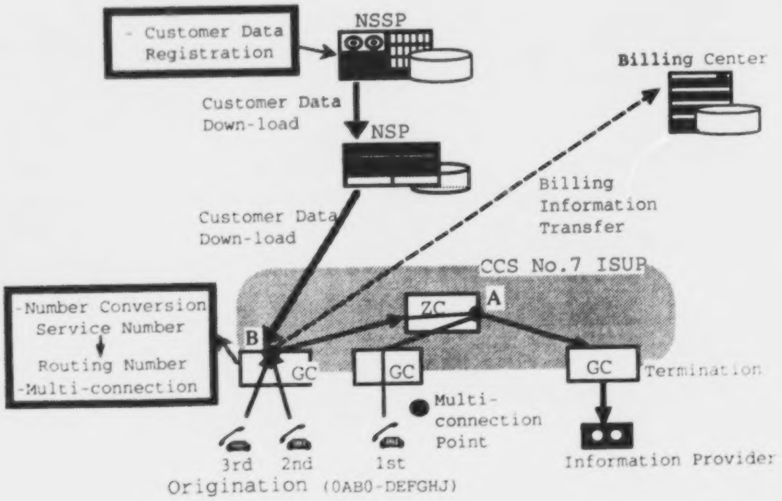
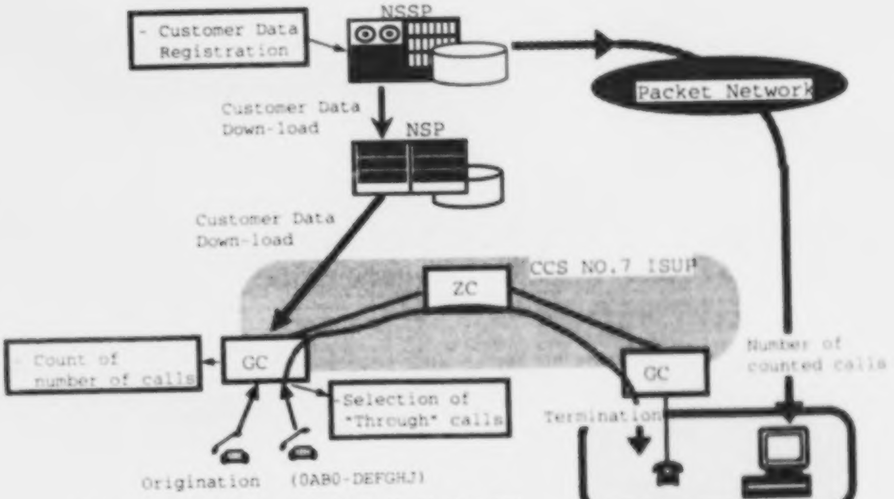

- Customer Data Registration
NSSP
Billing Center
Customer Data Down-load
NSP
Billing Information Transfer
Customer Data Down-load
CCS No.7 ISUP
-Number Conversion
Service Number
Routing Number
-Multi-connection
ZC
A
B
GC
GC
GC
Termination
Multi-connection Point
Information Provider
3rd
2nd
1st
Origination (0AB0-DEFGHJ)

Figure 2. MULTI-CONNECTION SERVICE

the CCS No.7 signalling network and intelligent nodes will be overloaded. As a result, other signalling messages even for general telephone calls will be affected. Therefore, a new method must be considered to handle mass traffic.
In the new Intelligent Network architecture developed for Mass Calling Service, necessary functions and customer data are down-loaded from intelligent nodes to GCs. By the down-loaded data, GCs can handle subsequent service calls in the same manner as an NSP. In this sense, an NSP exists virtually in GCs. This new method will be able to release NSPs from congestion caused by mass traffic. As a result, a considerably high number of calls can be handled simultaneously at GCs.

6. MASS CALLING SERVICE CENTER

NTT has established Mass Calling Service Center (MCSC) to operate these two services smoothly and efficiently. First, MCSC is responsible for the customer support. MCSC has a unique job in this task, which is program scheduling. The limitation on network resource restricts the number of programs which are offered at the same time under the circumstance of high traffic volume. Therefore MCSC maintains database which administrates a service execution schedule and detailed annual traffic data. Based on the database MCSC makes a judgement on the acceptance of the program from a standpoint of network capacity. A Mass Calling Service customer who is a producer of an audience participation program is required to submit the plan to MCSC in advance. If the plan is not feasible regarding network resource limitation, MCSC requests the customer to change the date or area of the plan. Once the plan is accepted, the program gets reservation status and customer data for the program is ready to be downloaded. MCSC is also responsible for the maintenance of service condition. Not only switching nodes but also intelligent nodes must work normally in high reliability all the time. Specifically at Telephone Voting Service it is necessary to inform the results of counted calls to a PC on the customer premises on the real-time basis as well as to complete and count thousands of calls. If any trouble happens in the NSSP, it is not possible to send the results to the customer even if GCs can complete and count thousands of calls. Therefore MCSC monitors all network resources such as NSSP,NSP,GCs and CCS No.7 signalling network to act quickly on troubleshooting.



Note: "Through" call: selected at random and connected to the customer terminal

Figure 3. TELEPHONE VOTING SERVICE

7. TOWARDS FUTURE ENHANCEMENTS

An Intelligent Network allows a network operator to provide a variety of advanced services such as Mass Calling Service to satisfy both customer and network operator requirements. However, an Intelligent Network is not sufficient by itself without the bearer network being improved in parallel.

Figure 4 shows the evolution plan of NTT's Bearer Network. By 1997 all of the Bearer Network will be digitized. A Fiber To The Home (FTTH) plan will be completed by the year 2015. The evolution of both the Intelligent Network and Bearer Network enables NTT to provide telecommunications customers with various advanced services efficiently and smoothly.

Towards the coming 21st century, NTT is planning to provide VI&P services: Visual, Intelligent, and Personal services. These new services will become available only when both the Intelligent Network and Bearer Network are completely established.

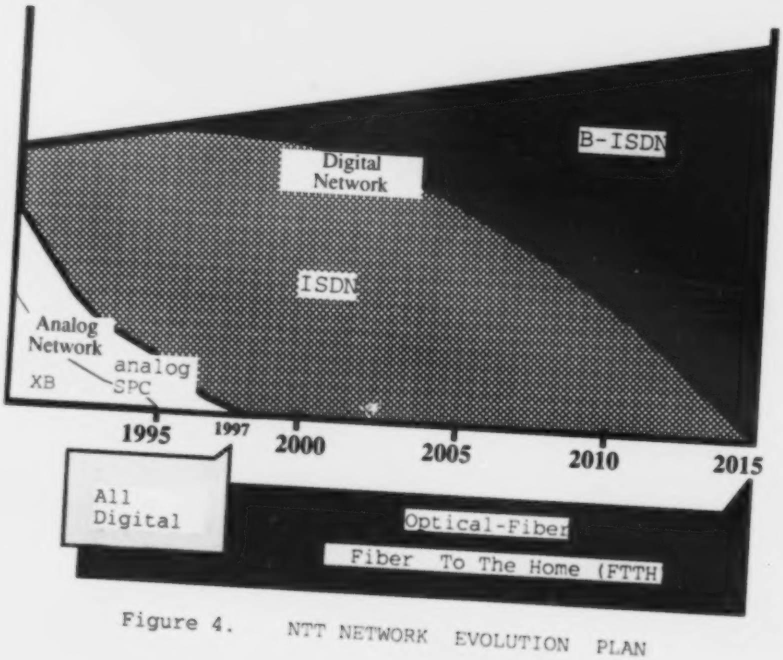


Figure 4. NTT NETWORK EVOLUTION PLAN

VIRTUAL COMMUNITIES IN JAPAN

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1. ABSTRACT

In recent years, virtual communities have proliferated thanks to the converging technologies of telecommunications and computing. In the United States, numerous virtual communities exist in the form of bulletin boards, newsgroups, computer conferencing, etc. and have been expanding its scope beyond the national boundaries. But, those virtual communities originating in the United States carry heavy American-biased culture which members often take for granted because of the long history of domination in developing computer networks by American organizations. As examples of alternative virtual cultures, this paper presents major virtual communities in Japan which originated in Japan and mainly sustained by people in Japan.

2. INTRODUCTION AND BACKGROUND

The convergence of telecommunication and computer technologies has enabled networking of people regardless of their geographical and temporal differences. The scope of such computer networks has been expanding exponentially since the first extensive computer network, ARPANET, was created in 1968 by the Advanced Research Projects Agency of the U.S. Department of Defense (now DARPA, the Defense Advanced Research Projects Agency). Now its successor, Internet, comprises 1.7 million computers in more than 125 countries (Stix, 1993); most of them at universities, government agencies and companies. As such computer networks have expanded beyond the small communities of scientific researchers and been applied in a variety of fields such as education and business, communication through such computer networks is beginning to alter the ways in which people interact with one another in formal and informal ways.

2.1. Computer-Mediated Communication (CMC)

The term, computer-mediated communication (CMC) or computer-based communication, encompasses: computer networks, electronic mail, electronic bulletin boards service (BBS), and computer conferencing. CMC has been fairly well studied in educational settings, as a supplemental to traditional classroom teaching or as a deliverly mode of distance education because of its distinct characteristics which make it different from any other media. Poster (1990) notes that CMC substitutes writing for spoken conversations and extends the domain of writing to cover areas of communication that previously were limited to face-to-face interactions, mail, and the telephone.

CMC, up to now, is mainly limited to textual communication where most of the social cues are stripped off. People only see text on the computer screen in standardized formats which contains no dynamic personal information such as tones of one's voice or undescrivable facial expressions. 'Phatic' aspects of the face-to-face conversation are minimal in CMC, which sometimes exacerbates communication anxiety when the sender gets no reply (Feenberg, 1989).

The advantage of such text-based communication is that it reduces discriminatory communication patterns based on physical and social cues such as gender, race, socio-economic status, physical features, etc., and enhances the interaction with one another. As a result, CMC destabilizes existing hierarchies in relationships and rehierarchize communications according to criteria that were previously irrelevant (Poster, 1990). The text-based communication also augments the interaction with ideas generated through discussions. In CMC, people tend to focus on the message more than the messenger, and the availability of an archived transcript of the proceedings facilitates review of previous comments and discussion, focusing on important ideas and concepts.

Another important aspect of this standardized texual communication is an individual's great control of his/her self image presented to other people. In most cases, the only identity an individual user has is a "handle" name which may be, and most often is expected to be, fictional. Anonymity is complete and identity is fictionalized in the structure of the communication. Poster (1990) contends that "computer conversations construct a new configuration of the process of self-constitution." Communicaters can compose themselves as characters in the process of writing, inventing themselves from their feelings, their needs, their ideas, their desires, their social position, their political views, their economic circumstances, their family situation - their entire humanity.

In this sense, CMC is used for what Morioka (1993) calls "ishiki tsushin (conscious communication)". "Ishiki tsushin", according to Morioka, is the communication for the purpose of social interaction itself, which is distinguised from "joho tsushin (information communication)". Goffman (1959) argued that individuals deliberately "give" and inadvertently "give off" signs that provide others with information about how to respond. Because of its anonymous nature of CMC, communicators can manipulate images of themselves much better than in face-to-face situations and present themselves anyway they want to be thought of. By doing so, people can fulfil the unmet desire to be a person whom they want to be.

In one sense, CMC enhances the sense of personal freedom and individualism by reducing the 'existential' engagement of the self in its communications (Feenberg, 1989). On the other hand, Poster (1990) contends that the CMC users are bounded in many ways:

> first, to the new, computerized system of positioning subjects in symbolic exchanges; second, by the prior constituting of the self, typically the experience of that self as restricting, evoking the sense of transgression when that self may be concealed or suspended; finally to the language used in the conversation, with all its semantic, ideological and cultural specificity, a specificity which does not diminish when converted into ASCII codes.

CMC is usually asynchronous although there are also some synchronous applications. The advantage of asynchronous communications is that people can read, reply or send messages at their convenience. It is not only a matter of personal convenience, it means communication crosses time as well as space. Poster (1990) argues that CMC disperse the subject, dislocating it temporally and spatially. CMC also has multiple-receiver addressability. People can send a message to any number of people as long as the receiver has access to the electronic community.

2.2. Virtual Communities

Marshall McLuhan (1964) said that the global media information networking would make us live in a global village. Subsequently, Webber (1967) argued the "nonplace community" which existed beyond any geographical boundaries. According to Webber, the traditional concept of "communities" which is geographically bounded should be replaced by the concept of "communities" of accessibility. Thanks to the modern communication technologies, now communities can exist regardless of members' geographical locations. In Jessie Bernard's (1973) terms, CMC changes "the significance of space for human relationships . . . we do not need the concept of community at all to understand how a society operates." Hiltz and Turoff (1978) extends this view by saying that:

> We will become the Network Nation, exchanging vast amounts of both information and social-emotional communications with colleagues, friends, and "strangers" who share similar interests. . . . we will become a "global village" . . . An individual will, literally, be able to work, shop, or be educated by or with persons anywhere in the nation or in the world.

CMC builds nonplace communities of common interests, affinity, and association. They are called "online communities", "electronic communities", or "virtual communities." Those usually exist in the forms of online discussion groups such as those found on the global Internet and USENET computer networks, commercial videotex systems, and personal computer bulletin boards. Such communities are dynamic; many people come and go at any time in the life of a community. There are two kinds of virtual communities. The first one is the community where members know one another and usually have met face-to-face. CMC (especially electronic mail) is used mainly to maintain their routine communication, discuss issues relevant to the members, or collaborate on some projects. The second category is the community where members do not necessarily know one another, but share common interests, value systems, or goals. CMC (especially BBS and computer conferencing) is used mainly to exchange information and ideas. The major differences of such virtual communities from traditional communities are 1) the freedom from geographical limitation; 2) the accessibility at one's own convenience; 3) the retrievability of information/messages, and 4) the limitation of communicative acts to textual messages.

Those communities, however, are not entirely new and completely different from traditional communities. Morioka (1993) argues that those virtual communities are just the geographical expansion of traditional communities in the sense that the members of a communitiy use CMC as a means to discuss and exchange information instead of meeting face-to-face.

In addition to the above mentioned communities, another kind of communities exist in computer networks, which can be called "communities of anonymity [*tokumeisei no komyuniti*]" (Morioka, 1993). These communities of anonymity are the communities whose members are anonymous and share virtual spaces for their self-expression which may not be possible in the situation that they have to identify themselves. In such virtual spaces, people play whatever role they want to play, knowing other people are also presenting created images of themselves. In many computer bulletin boards, it is well known that some people use opposite sex's handle names (i.e., a man uses a female name or a woman uses a male name) and play the role of the opposite sex to their own. In such communities, people enjoy the virtual aspects of communication per se.

In summary, there are basically three kinds of virtual communities: 1) the ones totally overlapping with physical communities; 2) the ones overlapping with physical communities to some degree; and 3) the ones totally separated from physical communities.

3. COMPUTER-MEDIATED COMMUNICATION IN JAPAN (*PASOKON-TSUSHIN*)

Most of the computer networks in early days started in the United States. In Japan which seems to be such a technologically advanced society, the computer-mediated communication has not been as prevalent as that in the U.S. According to Hiroshi Inose, director general of the National Center for Science Information Systems, Japan's computer networks are estimated to be lag behind those of the U.S. by about 10 years (Hamilton, 1993). There are several reasons for the unpopularity of computer-mediated communication in Japan.

First of all, in business Japanese people still tend to rely on face-to-face communication instead of doing business through some mediated communications, mainly because of the high context culture of Japan where people tend to read between lines a lot with the help of social cues such as facial expressions, tone of voice, the posture, etc. In addition, as most business people in Japan do not have individual offices and have no need to use e-mail to contact others in the office, LAN has not been widely implemented. It has begun to be used only recently with the "downsizing" trend.

Secondly, unlike most parts of the U.S. where local telephone charge is a flat rate regardless of the number of calls and the total communication time, Japan's local telephone service is charged per minute. It has discouraged people to have modems at home.

Thirdly, there have been a negative stereotypical image about people indulging in computer communications who are pejoratively called "Otaku-zoku" meaning unsociable home-bound people.

Lastly, the majority of average Japanese have never learned to use a keyboard; in addition, unlike typing English, typing Japanese requires additional key strokes for inputting by Roma-ji which is a way of transcribing Japanese phonetically into the Latin alphabet, selecting appropriate Kanji, and shifting the mode of characters between Hiragana and Katakana. This may be the main reason why facsimile is more common than e-mails in business communication.

In Japan, there are two distinct realms of computer-mediated communication, each of which seems to have little interest in or awareness of the other. In the following, one realm called "pasokon tsuushin" is discribed followed by the other, "Internet", realm.

"Pasokon tsuushin" refers to public access BBSs and commercial online services to which personal computers at home or in offices are connected. Recently, such computer networks are gaining popularity among people who are not so-called "techie" and commercial online services such as NIFTY-Serve of Fujitsu and PC-VAN of NEC (the two biggest commercial computer networks in Japan which have about 540,000 members and 578,000 members respectively in August, 1993) are showing a tremendous growth in their memership. NIFTY-Serve is affiliated with CompuServe in U.S. and members of NIFTY-Serve can have access to CompuServe without any additional fees. In a similar vain PC-VAN has an affiliation with GEIS (General Electric Information Services) and members of PC-VAN can have access to GEnie.

The number of total users of computer networks in Japan is estimated to be around 1,5 to 2 millions including some overlaps in membership (Nikkei Communications, 1993). Most of the commercial computer networks had not been interconnected, but recently major ones began to be interconnected through their electronic services. Now both NIFTY-Serve and PC-VAN are connected to the Internet though connection is limited to the exchange of electronic mail messages.

According to a survey of 969 users of commercial computer networks (Kawakami, et al. 1993), the largest number of people answered that the motive of using the computer network was to obtain the information they want. However, it is noticeable that a large number of people also listed interpersonal communication (e.g., to exchange e-mails with friends, to have discussion with those who have same interests, to find a new friend, to express his/her own opinions and ideas, to communicate anonymously, etc.) as the motive to use computer networks.

Recently, people in business also started to utilize such commercial computer networks for the communication with their customers such as user supports and product supports.

3.1. Communication Styles in Computer Conferencing

Among many services offered in computer networks, computer conferencing such as SIG (special interest group) and Forum is the most popular and thus the most profitable service for commercial network service providers (more than 60% of the total access time is dedicated to such conferencing). At present the PC-VAN has about 150 such SIGs and the NIFTY-Serve has approximately 290 Forums. A Forum or a SIG is further divided into several conferences of specific topics under a general theme of a particular Forum or SIG. Most participants of the Forums or SIGs use handle names so that anonymity is maintained for those who don't want to disclose their personal identities. Moreover, in the NIFTY-Serve there is a function called "Home Party" where members create their own passwords for a particular party and set up a small informal meeting place. The number of members in a Home Party ranges from a few to over 100 during the last few years.

Those SIGs and Forums are managed by so-called SYSOP (system operator) or SIGOP (special interest group operator), who usually are computer network enthusiasts and volunteer to spare their time in running the confernces. Some SIGOPs are admitted to become one after applying for establishing a SIG; Some are entrusted by a network operation center; and others were asked by the previous ones. Those SIGOPs sometimes appoint sub-operators and board leaders as occasion demands. Usually there is no tangible reward for being a SIGOP/SYSOP. The degree of influence a SIGOP/SYSOP has on the nature of discussion in the SIG varies.

Because commercial networks are trying to avoid cancellation of membership by users as much as possible and most SIGS and Forums are moderated by SYSOPs or SIGOPs, discussions in these SIGS and Forums maintain relatively high quality and "flaming" messages are usually elimitated.

In those Japanese online communities, people who read messages in computer conferencing but do not usually reply are called ROM (read only members) (In U.S. those are called "lurkers".) and those who actively participate in the conferences are called RAM (random access members or radical active members). One study showed that 83% of the people who subscribed to a conference had never "spoken" and, among those who had spoken at least once, the two-third of them had spoken less than three times (Kawakami, 1993). It is common in computer conferencing that a few people speak a lot while a majority of people only "listen."

Kawakami (1993) listed six reasons why ROM outnumbered RAM a great deal:

1. reluctance to speak to people whom they don't know,
2. resistance to participate in the group which has been already formed and developed without them,
3. lack of expertise to participate and fear of being evaluated by others;
4. difficulty of deciding to what extent they should disclose themselves to others;
5. worry of not knowing how clearly they make themselves understood; and
6. fear of getting criticism from others.

It should be noted that a ROM in one conference may be a RAM in another conference and a RAM in one conference may be a ROM in another conference; ROM and RAM are not the labels attached to individuals but the roles in one particular conference.

3.2. Emoticon (Emotional Icon)

Because computer-mediated communication is basically texual communication which lacks in social and nonverbal cues seen in face-to-face conversations, unintended confrontation often occurs as the result of misunderstanding. One way to lessen this problem is the use of "emoticons" or "smileys" to complement the lack of social cues in CMC. Interestingly, smileys (or emoticons) used in Japanese computer networks are a little different from those used in American or European networks, reflecting its unique culture.

typical smileys used in U.S./European networks		**typical emoticons used in Japanese networks**	
:-)	regular smile	(^_^)	regular smile
:-(	sad	(^o^;>)	Excuse me!
;-)	wink	(^ ^;)	cold sweat
:-))	very happy	(^o^)	happy
:-o	Wow!	(*^o^*)	exciting
:-|	Grim	(_o_)	I'm sorry
:-||	anger	(^ . ^)	girl's smile
8-)	smile with glasses	(*^_^*;)	sorry
:^)	happy face	(;_;)	weeping
:^(	unhappy	(^_^;;	awkward

As you see, smileys used in U.S./European networks have to be looked at sideways while emoticons used in Japanese networks are not. According to a study of the major nationwide noncommercial computer network in Japan, JUNET, by Nojima (1993), smileys are used to show (a) an affection or (b) that it's meant as a joke. The use of smileys to indicate a joke is also common in American/European networks, but its use to show an affection without any specific indication is unique to Japanese networks. In addition, Nojima also pointed out that sometimes smileys are used to apologize some possible offense.

In high context cultures such as Japanese which rely heavily on contextual cues to communicate, people tend to pay special attentions to the politeness, appropriateness, the non-offensiveness, etc. even in textual computer-mediated communications. It is debatable that the use of smileys and emoticons is the best way to compensate for the lack of contexual cues; however, it is true that such smileys and emoticons are the cultural products of virtual communities.

In addition to the emoticons, a variety of colloquialism such as dialects and infant languages, or vocalization of non-verbal behaviors are being employed to convey some contextual information which is difficult to be transmitted via text only.

3.3. On-Line and Off-Line Meetings

People who get to know one another through computer networks often gather physically as well. This is called off-line meetings (or *Ohumi*). Usually such off-line meetings are held within a specific SIG or Forum where the dates and places are posted and members reply to them indicating if they're going to attend or not. Kuroiwa (1993) points out that most of the members who attend such off-line meetings are those who are active in having chat (real-time electronic conversation) in each SIG or Forum; not necessarily active in participating in the discussion of the SIG or Forum itself. He hypothesizes that it is because off-line meetings are considered to be the extension of online chat.

Both on-line chat and off-line meetings are the communication by those who share the same virtual or physical space at a particular moment. It is different from a regular on-line discussion which is asynchronous and where spontenaity is minimal. From a business perspective, off-line meetings are considred to highten the members' sense of belongingness to the specific SIG or Forum which holds a meeting and strengthen the cohesiveness among its members. It usually results in the overall increase of participation in the SIG or Forum.

However, not all kinds of Forums or SIGs are holding such off-line meetings. Those Forums or SIGs whose main purpose is to exchange information such as computer-related ones usually don't hold any off-line meetings. On the other hand, the Forums or SIGs relating to lighter subjects such as hobby, living, music, sports, etc. tend to hold off-line meetings.

Many people who attended those off-line meetings mentioned that they did not feel like meeting another member for the first time. This tendency seems to be stronger in this kinds of off-line meetings (face-to-face meetings after participating Forums or SIGs online) than in the meetings held after some initial telephone conversations. Kuroiwa (1993) explains that it is because in CMC people discuss topics more in depth and rather informally. Sometimes a phenomenon called "network-high" (which has been discussed in the news group, fj.soc.media,) occurs when a newcomer to a computer conference such as a Forum or SIG becomes addicted to the conference.

4. INTERNET IN JAPAN

Internet is the massive world-wide network of computers, comprising of thousands of smaller regional networks and connecting over 4 million users scattered throughout the globe. Although Internet is somewhat new in Japan, currently there are 21,252 Internet hosts in Japan (Quarterman & Carl-Mitchell, 1993). Apart from the commercial networks such as the NIFTY-Serve and the PC-VAN, such Internet hosts in Japan provide academic communities with network infrastracture to facilitate collaboration and information exchange among researchers and scholars. Unlike the Internet in U.S. which is gaining tremendous popularity even among those who are not within the academic communities, Internet in Japan is still somewhat limited to researchers in universities, people in research laboratories of consumer electronic or computer manufacturers, and students in computer scinece.

The advancement of Internet in Japan has been somewhat slow compared with that in the United States due to several reasons listed below.

1. Centralized computing has been dominant in Japan, used by banks, security houses and railway systems, etc., and even ministries like the Ministry of Education and the Agriculture Ministry have their own networks that are not linked to each other.
2. LAN has not been widely implemented in offices. Even those companies who have implemented LANs don't have much interest in interconnecting with others.
3. Computer manufacturers in Japan such as IBM, Fujitsu, Hitachi, NEC, and DEC have been using proprietary network protocols, which has made internetworking difficult.
4. The TCP/IP protocol has not been recognized as a standard protocol.
5. Routers have not been readily available with support and training in the Japanese language since most routers have been developed in U.S. and their design requires detailed knowledge of a variety of protocols.
6. Postal regulation and high cost of leased lines have not encouraged personal communication on networks. NTT has been making a big effort to make ISDN a nation-wide service while keeping leased lines relatively expensive.

   As a result, the ISDN service is available in most cities in Japan but the cost to use leased lines has been kept high.

7. With a population largely concentrated in a few urban centers in the same time zone, not much demand for delayed network communication.
8. There have been several incompatible methods of encoding Japanese texts (a 10,000 plus character system) into computers. (This is detailed in the following section.)

4.1. Japanese Encoding Methods

As mentioned above, one of the reasons why the advancement of Internet in Japan has been somewhat slow compared with that in the United States is because of the difficulty of handling Japanese text in computer networking. Since there are different encoding methods (JIS, Shift-JIS, and EUC) to input Japanese as well as different character sets, it is not as simple as using the ASCII character set to exchange Japanese texts between different machines.

JIS (Japanese Industrial Standards) encoding is being used for external information interchange (i.e., moving information between computer systems) such as e-mail since JIS encoding is not very efficient for internal storage or processing on computer systems. JIS encoding makes use of seven-bit for representing two-byte characters and escape sequences to switch between one-byte seven-bit ASCII and two-byte seven-bit Kanji character modes. All the Japanese texts which are composed with encoding methods other than JIS have to be converted to JIS encoding before being sent out as e-mail (Lunde, 1993).

Another encoding method, Shift-JIS encoding, was originally developed by ASCII Corporation in collaboration with Microsoft and is widely used as the internal code for Japanese PCs and KanjiTalk (the Japanese operating system for Apple Machintosh) as well as the millions of inexpensive portable Japanese language *waapuro* (word processors) that have flooded the market. It is a combination of a one-byte eight-bit code and a two-byte eight-bit kanji code, and uses no escape sequences. The conversion between Shift-JIS and JIS requires a complex algorithm (Lunde, 1993).

The third encoding method, EUC (Extended UNIX Code) was developed by AT&T UNIX Pacific and is implemented as the internal code for most UNIX workstations configured to support Japanese. EUC is a two-byte eight-bit code and supports not only Japanese but multiple character sets within a single text stream. Although EUC does not make use of escape sequences as JIS does, EUC encoding is closely related to JIS encoding and conversion between EUC and JIS is easier (Lunde, 1993).

4.2. N1net

The first attempt to build a nation-wide academic network, the N1 project, was started in 1974. With the support from the Ministry of Education, three universities (Tokyo, Kyoto, and Tohoku), a common carrier (NTT), and three computer manufacturers (Hitachi, Fujitsu and NEC) participated in the project. The N1 protocol developed in the project was modeled after the ARPANET protocol. This network was the very first WAN which employed the commercial packet-switching service called DDX -P, the domestic Japanese X.25 network started by NTT in 1980 (Ishida, 1992).

At that time, encoding Japanese texts was still difficult and the significance of electronic mails and news exchange facilities had not been fully realized yet. Unlike the American counterpart, the N1net was a resource-sharing network but not an interpersonal communication network. On the other hand, the specification of the N1 protocol has been made public and the N1 protocol became the only network protocol in widespread use for linking heterogeneous computers (Ishida, 1992).

4.3. JUNET

JUNET (Japanese Unix NETwork) is the first nationwide noncommercial computer network designed for e-mail/e-news exchange. It was started experimentally in October 1984 by connecting two public universities (Tokyo Institute of Technology, and Tokyo University) and one private university (Keio University) through public telephone lines (at 9600bps) with UUCP (Unix to Unix Copy) protocol. JUNET utilizes UUCP connections instead of full IP connections and its services are basically limited to news and electronic mail. When JUNET began, international communications had to be in English or romanized Japanese, but later Kanji support in a windowed user interface to the messaging systems was included. Since then the amount of public traffic as well as JUNET membership has increased dramatically (Shapard, 1993). Subsequently the network has expanded throughout the major Japanese cities by adding a new site to an existing one. There are around 750 participating organizations (not only universities but also industrial research laboratories) in December, 1992. Its success mainly owes to the fact that it did not rely on government funds and it was operated completely on volunteer basis (Ishida, 1992).

Since its inception, the administrators of the major hosts on the network had administered the network voluntarily and hold meetings monthly. Each host's connection costs have been paid by its institution. However, due to the recent tremendous increase in traffic, JUNET could no longer rely solely on such voluntary management system. Accordingly, in December, 1991, JNIC (Japan Network Information Center) took over its network management (mainly maintenance and allocation of domain names and IP addresses) and also JUNET Society was established in May, 1992, as the chief representative body of JUNET.

In April 1993, JNIC changed its name to JPNIC and started serving as a information provider of Japanese research networks in addition to the network maneger.

4.4. BITNETJP

BITNETJP, an extension of the BETNET to Japan, came into existence in 1986 by the support of IBM when the Science University of Tokyo established a 56 Kbps link with the City University of New York. This is considered to be the first international internetworking in Japan. BITNETJP is now a consortium called the Japan BITNET Association comprising of 82 institutions, most of which are private universities in Japan. There had been some confusion in using Japanese characters on BITNETJP mails but it's Kanji code was standardized to JIS 7-bit code in April 1992. BITNETJP has formed CAREN (Consortium of Asian Research and Educational Network) with Taiwan and Korea in July 1991.

4.5. WIDE Internet

WIDE (Widely Integrated and Distributed Environment) Project is a research project initiated by Dr. Jun Murai (then with University of Tokyo) in 1986 in cooperation with universities, national research institutes, and industrial research laboratories to design "the future JUNET". The main objective of the WIDE Project is to demonstrate the technology to establish widely integrated distributed environment based on the hierarchical structure of regional disrtibuted environments.

The WIDE Project was the first wide area IP network in Japan which employed 64-192 Kbps leased-lines to inter-connect LANs in many institutions. With substantial help from Prof. Torben Nielsen at the University of Hawaii, WIDE established a 64 Kbps international link to the US Internet through Hawaii in 1989. Through WIDE, it became possible to use telnet and ftp services internationally in much the same way as in the U.S. Internet. Since WIDE is maintained in a research project, many research activities are being carried out using WIDE as a testbed. At present, over 80 researchers are participating in 16 working groups of such topics as data link, ISDN applications, multicast, TCP/IP over X.25 and satellite communications, multimedia, etc.

The network the WIDE Project operates is called WIDE Internet which consists of 8 WNOCs (WIDE Network Operation Centers) and IP (internet protocol) backbones (64 - 384 Kbps) connecting them (Sunahara, 1993). Though around 50 cooperations are connected to the WIDE Internet at present, it is forbidden to use the network for commercial purposes. Since September, 1992, the WIDE Internet has expanded its connection with commercial networks experimentally and now it becomes possible to exchange electronic messages with the users of NIFTY-Serve and PC-VAN as well.

4.6. Other Networks

In addition to the WIDE Internet, there are some other IP-based research networks which have been developed independently: TISN (Todai International Science Network), JAIN (Japan Academic Inter-university Network), SINET (Science Information NETwork), HEPNET-J (High Energy Physics NETwork in Japan), and TRAIN (Tokyo Regional Academic InterNet). The transmission speed of those networks is currently limited to 64-192 Kbps because of high tariffs, lack of funding and lack of coordination (Ishida, 1992).

TISN is the network which connects the Engineering Department of the Univeristy of Tokyo, 25 major research institutes in Japan, and the University of Hawaii with DECnet and TCP/IP. TISN was started in 1989 and now has a 128 Kbps link to the US Internet through the University of Hawaii.

JAIN is an experimental academic internet linking Tohoku University and other 82 universities mainly with X.25 packet switched lines provided by NACSIS (National Center for Science Information Systems). SINET is a backbone network maintained by NACSIS and connects nine universities and six networks at the speed of 128 - 256Kbps. Those IP networks maintain a strict AUP (acceptable use policy) and private corporations do not have access to the above networks except the WIDE Internet.

In addition, there are a number of regional networks built around the major universities in a particular region: e.g., TRAIN (Tokyo Regional Academic Network), Tohoku-INET, Tokai-INET, FAIRnet, KARRN (Khyshu Area Regional Research Network), and NORTH (Network Organization for Research and Technology in Hokkaido).

In order to correspond to a increased demand of the network connectivity from various fields, a commercial service of providing Internet connections is going to be started in the late 1993 in cooperation with the WIDE Project.

4.7. Inter-Agency Research Information Network

Science and Technology Agency (STA) in Japan has proposed development of a high speed "inter-agency information network" connecting about 100 major governmental research laboratories under various ministries and agencies with optical fiber networks to be leased from commercial vendors such as NTT. Is is also being planned to eventually connect the inter-agency network to NSFNET or other backbone networks in the United States, as well as with research networks in other foreign countries (Tokyo Office, 1993).

4.8. JUNET News Groups

NetNews, one of the applications of the Internet, is very popular among the users of the Internet worldwide. Those newsgroups which originate in Japan and usually written in Japanese are the ones started with fj.* (meaning 'from Japan'). Like SIGs and Forums in "pasokon tsushin", Fj newsgroups are computer conferences of a wide variety of topics. Fj newsgroups and SIGs/Forums share some characteristics of Japanese virtual communities. However, one big difference is that in Fj newsgroups total anonymity is not allowed and it is the norm that a poster should identify him/herself first at the beginning of every message. This may be due to the fact that Fj newsgroups consist of those who are in academic or scientific communities and getting to know people in the field is also a major purpose of participating such newsgroups.

Currently there are around 175 Fj newsgroups whose topics include administration of newsgroups, computer programming, computer hardware/software, life in Japan, annoncement for conferences, various hobbies and recreations, science, societal/cultural issues, etc. There is a constant debate of setting up new newsgroups or killing old ones and the total number of Fj newsgroups is changing constantly. Overall, the number of Fj newsgroups is increasing over the years. Not all the newsgroups are active and some of them haven't had any discussion for several months. The most active newsgroups on average are:

fj.jokes	anything about jokes and humor
fj.rec.rail	discussion about railways and railroads
fj.living	discussions about things in daily life
fj.rec.autos	discussions about automobiles
fj.sys.mac	discussions about the Applie Macintosh
fj.forsale	short, tasteful postings about items for sale
fj.rec.animation	discussion about animated movies
fj.rec.comics	the funnies, old and new
fj.rec.games.video	discussion about video games
fj.soc.men-women	discussion about fairness, right, etc between men and women

Fj Newsgroup Committee manages overall Fj newsgroups' activity and discusses the creation of new newsgroups, consolidation of existing newsgroups, and the abolition of inactive newgroups. Among these newsgroups, some are moderated and some are not; some are closed (only registered members can join) and some are open to general public.

During a two-week period, there are on average about 2500 posters and among them the number of messages per poster usually ranges from around 100 to one. About fifty percent of the total posters post only one messages and about 85% posted less than five messages. As you see, it seems that only a few people post heavily and majority of them post sparsely. Among the total posters, less than five percent are female posters. This underrepresentation of women in newsgroups reflects the underrepresentation of women in the computer-related professions in the real life.

5. CONCLUSION

This paper tried to show various distinct characteristics of virtual communities in Japan. A variety of virtual communities are emerging worldwide within the constantly expanding cyberspace. To some extent, virtual communities are formed with the influence of cultures of existing physical communities. But at the same time, they also create new cultures within the technological limitations and existing social norms.

Virtual communities do not require any fancy technologies such as ISDN and fiber optic cables; They can exist in regular public telephone lines. With the present technology, it is possible to create a global virtual community without any geographical restriction. However, it is often overlooked that the constituency of such virtual communities are the real human beings who are usually bound to a particular culture and a social structure.

Though to a large extent such cultural differences are hidden in cyberspace because of the current technology, it is dangerous to assume that the people you are communicating with in cyberspace have the same cultural background.

As virtual communities expand their scope and play more significant roles all over the world in the future, international or more precisely multicultural collaboration becomes critical for surviving. Accordingly, it becomes important to design communication systems which are sensitive to different cultural values and social principles. In future, the more sophisticated communication technologies are going to be incorporated into the infrastructure of virtual communities, the firmer bases may be needed to build communities which are global in social and cultural as well as economic and technological sense. The next missing link we have to overcome may no longer be technological one, but cultural one.

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Exploiting Technological Convergence to Stimulate Telecommunications Infrastructure Development

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Abstract

This paper focuses on exploiting areas of synergy and potential benefits due to the convergence of technologies of telecommunications services. In areas where regulations allow, or where the communications infrastructure is still in development, there can be economies of scope available in exploiting common infrastructures. Exploiting these economies can provide a "jump start" in infrastructure development by lowering overall costs, stimulating the development of new services and, at the same time, modernizing the network.

Introduction

In some countries, there is a focus on building a national electronic super-highway as a tool to enhance economic competitiveness. This new infrastructure provides the opportunity to exploit high-speed facilities (fiber optic-based) to create new information services. Applications range from technology-based workforce training and distance learning to collaborative research and transfer of medical images.

In developing countries, economic development is tied to the availability of a modern information and telecom service infrastructure. The direct benefits of telecom (reduced costs in travel) and greater efficiency (speed of doing business) are key enablers in development of the information economy.

The following sections present examples of how to exploit technology convergence from the perspective of three different network infrastructures:

- wireless communications, integrating domestic and international traffic,
- electric power grid, to facilitate intra-country infrastructure development,
- terrestrial telecommunications and cabledistribution networks to enhance local service viability and speed up the introduction of new multimedia services.

While not an exhaustive list of convergence possibilities, these three examples can be used to draw general conclusions and make policy recommendations.

Case Study I: The Wireless World

Wireless technologies, once confined to specialized services such as radio dispatching and international communications satellite links, are becoming ubiquitously available in many parts of the world. Wireless technologies include cellular telephones, mobile satellite terminals, cordless telephones, mobile data terminals, pagers, etc.

Three technologies that can be combined to create an "instant" infrastructure for telephony, independent of the existing facilities are: satellite earth stations for international circuits, point-to-point and point-to-multipoint microwave radio for rural areas, and cellular telephone systems for urban and semi-urban areas. This approach is illustrated in Figure 1.

The wireless infrastructure can be used in either an overlay mode, or in a replacement mode. In the case of overlay, the wireless network provides a second infrastructure in parallel to the existing wireline infrastructure. In the case of replacement, the wireless infrastructure can be used instead of the existing infrastructure.

Analysis

Many developing countries are characterized by a high concentration of population in one (or more) metropolitan area(s), with the remainder of the population spread over large rural areas. Commerce, trade and most economic activities are thus focused on the major metropolitan area(s). With the continuing growth in urban populations, telecom services are consequently heavily biased in favour of traffic within urban areas, from rural areas to urban areas, and from the major urban "gateway" areas to other countries.

The combination of a wireless infrastructure with the international gateway provides a flow of revenue from international services (an important source of foreign exchange) which helps to pay for the cellular infrastructure. Since the cellular infrastructure would also be built using recognized international standards (such as the Global System for Mobile communications, or GSM), travellers from other countries could make use of the network while visiting, increasing traffic and hence revenues accruing from the system.

Combining cellular services with an international gateway would be primarily a way of serving the urban population. Once this infrastructure is in place, telecom service can be extended in a number of ways:

- extension of cells along key transportation corridors and to neighbouring cities,
- installation of fixed cellular payphones in areas with cellular coverage to improve access to telecom services and to provide emergency calling facilities,
- linking of outlying areas using point-to-point or point-to- multipoint microwave radio which can be tied into the trunking facilities used for cellular, or "beamed" directly back to the urban switch; wireless data terminals could be included in a similar way for applications such as public security (police, ambulance dispatching), point of sale terminals (bank machines, credit card verification) and remote monitoring (pipelines, power grids).

Benefits and Difficulties

The primary benefit of wireless communications (from the point of view of capital investment) is the lack of dependence on a terrestrial (cabled) infrastructure. This characteristic can be exploited in areas where the existing infrastructure needs to be replaced, or where the geography has rendered terrestrial infrastructure impractical. The traffic flow, combined with relatively low cost trunking via digital microwave, means that a switch in the urban location can serve both urban and rural subscribers.

However, because wireless communications is independent of the terrestrial infrastructure there is inevitably a greater amount of intelligence and circuitry required in the subscriber sets. This greater sophistication yields a higher price at the consumer level. While overall the wireless "world" may be competitive with its wired counterpart, the investment shifts from infrastructure such as cables, poles, etc., to radio transmitters and receivers.

For cellular, in particular, it is unlikely that costs will ever be as low as for traditional telephone services, making widescale deployment for residential phones impractical. Deployment of a mix of cellular and microwave point-to-multipoint systems can serve to lower costs, making the wireless network competitive with a traditional infrastructure.

Case Study II: Fiber Optic Electric Power Lines

An untapped resource for providing or improving telecommunications services is the electric power grid. An essential aspect of any power system design is its communications system. Power companies have traditionally installed communications facilities in parallel to the power grid. These facilities are used to maintain reliability through control of remote relay and transformer stations and also for internal voice and data circuits. The communications system historically consisted of microwave radio facilities and/or leased telephone circuits.

Recently, power companies have been installing "optical ground wire" (OPGW) technology as a new way of building communications facilities. OPGW combines the functions of the conventional overhead ground wire with the carriage of communications circuits. The OPGW includes optical fibers which are carried inside the aluminum ground wire (from 6 to 48 fibers).

The optical fiber is the same type of fiber used by telephone companies in the provision of fiber optic transmission systems for telecommunications. Because fiber optic transmission is based on the modulation of lightwaves, it is immune to electrical and electromagnetic interference. Thus OPGW can be used for providing telecommunications circuits along the same route as the power line. Figure 2 provides a representation of how an OPGW-based communications system would be implemented.

Analysis

The main benefit to power authorities of implementing OPGW technology is improved reliability. The fiber optic communications facility provides improved responsiveness for control and monitoring. Fiber optics provides relatively error-free circuits, and when combined with digital processing, facilitates a global view of the power system through software diagnosis and management. Instead of localized reactions to individual relay and protection circuits, the power system can be dynamically adapted to changing overall load conditions. This improves reaction time, minimizing outages and equipment damage.

There are also significant cost reductions in not having to support parallel communications facilities along with the power line infrastructure. The incremental cost of including the fiber with the ground wire (i.e. the added cost of OPGW relative to existing types of ground wire) is very low. Thus it is in the power authorities' best interests to plan new transmission lines with OPGW.

Once the OPGW facility is in place it can also be used to provide backbone trunking for telephone circuits. Through cooperation with the telecom authorities, excess fiber capacity (or the fiber itself) can be used to support increases in inter-city telephone traffic. Deploying transmission equipment based on digital optical standards (e.g. Synchronous Optical Network - SONET) provides an efficient and easy way of combining traffic from multiple sources on the same line.

Sharing a common grid (combined power company and telecom lines) reduces the overall costs of telephone service. This allows the telephone authority to use its resources to build up local switching and access facilities. An additional benefit in congested areas is the use of combined right-of-way; i.e. the OPGW telephone lines do not require new access to civic infrastructure.

Power grids often reach into remote areas where telephone service is poor or non-existent. The OPGW facility provides a telecom pipeline into these areas, piggybacked on the power line and supporting rural telephone expansion and service improvement. Capacitive coupling techniques can also be used to provide low voltage powering from the high voltage lines to feed the telecom equipment.

Since electric power may arrive at a remote location (or the remote location may in fact be the electric power generating site) before telecom services, OPGW provides for an inexpensive way to get a "head-start" on telecom.

Benefits and Difficulties

The OPGW approach provides an inexpensive way of adding telecom capability to the power grid. This capability can then be used to support inter-city telephone trunking. The cost of an OPGW project is small compared to the cost of the high voltage transmission line.

On the other hand, the power and telephone authorities have to work together to ensure the success of an OPGW project. The power authority, for example, may be reluctant to install fiber capacity to support telecommunications without guaranteed traffic. Cooperation is required to maximize potential benefits.

It may also be difficult to justify replacement of existing ground wires because the power line needs to be taken out of service for OPGW to be installed, a costly and time consuming operation. However ground wires have a normal lifetime of 20 to 40 years, so they are being replaced on a regular basis by the power authority.

Quantifying the benefits of carrying telecom traffic could reveal that accelerating ground wire replacement is justified in particular cases, for example on lines scheduled for replacement on a 5 to 10 year horizon.

Case Study III: Terrestrial telecommunications and cabledistribution networks

The convergence of telecommunications and cabledistribution networks is a subject of much debate in North America and around the world. This debate is fueled by technological evolution enabling telephone companies to provide broadband, cable television-type services and likewise, cabledistribution service providers developing the capability to offer interactive video and telephony services. At stake is who will be most favorably positioned to provide the myriad of multimedia services which are expected to be offered to residential subscribers and be the source of future revenues.

In developing countries the question is also important as the penetration of television sets and broadcast services increases. A cabled infrastructure for television services not only can stimulate job creation in the domestic broadcast industry, but also provides a pipeline for distance education services.

Studies conducted to date have identified potential areas of synergy and convergence in the areas of network infrastructure between the delivery of telecommunications and cabledistribution services. In the case of developed countries, and where modern telecommunications and cabledistribution infrastructures already exist, savings currently are limited to the common use of physical support infrastructure (poles, conduits, etc.) in the local access network.

However, where investments in network modernization are required, or in the case of new builds where services are not yet available, a higher level of synergy between the provision of terrestrial telecommunications and cabledistribution services can be achieved.

Figure 3 highlights the evolution of telecommunications and cabledistribution local networks. It can be noted that, although the terminology used is different, fiber optic technology results in similarities in the network architecture being implemented by both types of service providers.

Analysis

A detailed investigation reveals the following areas of convergence and synergy between the provision of telecommunications and cabledistribution services.

In the case of backbone networks, high capacity digital fiber transmission systems can be used, either in ring or meshed configurations. Systems operating at speeds of up to 2.5 Gb/s can provide sufficient bandwidth to transport standard voice and data telecommunications services in addition to a large number of digitally compressed television channels.

For example, a 2.5 Gb/s system could carry in excess of 24,000 64 kb/s voice or data circuits and more than 300 television channels digitally compressed to 1.5 Mb/s (e.g. MPEG II). Synergies would then be realized in the installation of the fiber cable, in the cost of the cable itself and in the fiber transmission equipment. (Note: the same analysis can be done using lower bit rates and fewer numbers of channels).

A previous study has indicated that savings of up to 20% could be realized, considering only the installed cost of the fiber cable itself (independent of the number of circuits transmitted), if a single fiber cable was used instead of two separate ones. This implies some form of arrangement between the telecommunications and cabledistribution service providers, assuming they are different. A concept called the "cable condominium" approach has been proposed. However, little information exist to date as to its real life implications.

The complexity of the situation increases as we move closer to the subscribers. Today's digital fiber optic technology is not cost efficient as a direct link to each subscriber and is not expected to be so in the near future. Estimates in the range of a few thousand dollars per subscriber have been quoted, much higher than the cost of providing telephone service via copper or cable TV via coaxial cable. This implies that at some point in the local network, the fiber optic link needs to be terminated. Many terminologies have been used in the industry to illustrate this configuration such as Fiber-to-the-Curb, Fiber-to-the-Bridger, etc. Services are then further extended by copper and/or coaxial cable into the subscriber's home.

Many scenarios can be envisaged at this point. They can be summarized as follows:

- separate coaxial and copper cables to each home,
- a single cable sheath containing a coaxial cable and copper pairs to each home,
- telecommunications and cable TV services provided over one coaxial cable to each home,
- telecommunications and cable TV services provided over copper pairs to each home.

If separate transmission systems are installed over separate coaxial and copper cables, synergies can only be realized if both cables are installed simultaneously. However, the costs relative to the equipment and cables themselves can not be shared.

If a single cable sheath containing both coaxial cable and copper pairs, then a proportion of the costs associated with the cable itself are shared between telecommunications and cabledistribution services. Additional savings may also be realized in terms of physical support structures such as the use of common pedestals, street cabinets and powering.

The use of a single transmission medium, either coaxial cable or copper pair, to provide for both telecommunications and cable television type services is under discussion in the industry. Technologies are under development to achieve this such as Asymmetrical Digital Subscriber Line (ADSL) on copper, and Remote Antenna Driver (RAD: for wireless access) or other techniques for coaxial technology. These technologies and products are in early development stages and hold promise for future networks.

To summarize, important synergies between the provision of telecommunications and cabledistribution services can be achieved in backbone networks where the majority of the costs (cable, equipment and installation) can be shared between telecommunications and cabledistribution services. Synergies are maximized by extending this common fiber optic backbone as close as possible to the subscribers.

With today's technologies, the synergies in the distribution network can be maximized by then extending the service using a common cable sheath containing both coaxial cable and copper pairs. However, the delivery of the telecommunications and cabledistribution services still enters the subscribers home via separate transmission facilities.

Benefits and Difficulties

Combining the infrastructure to provide telecommunications and cabledistribution services provides many benefits, especially in the case of new builds or where major investments in network modernization are required as is often the case in developing countries. There are substantial cost benefits to be realized. It is therefore possible to achieve a faster deployment of a modern communications infrastructure than what could otherwise be possible.

In addition, the bandwidth bottlenecks present in today's communications networks can be avoided. This provides an opportunity for developing countries to leapfrog technology generations and implement an infrastructure that can support today's telephony and cable TV services as well as a myriad of emerging multimedia applications. This in turn can foster the development of services such as distance learning and tele-medecine and generate substantial social benefits to the populations served.

Difficulties are to be expected in developing the right incentives and mix of service operators so that the synergies described above can effectively be realized. In many cases, appropriate regulatory policies would be required to ensure a certain level of competition between service providers and to foster entrepreneurship and the deployment of new services.

It should also be noted that combining the delivery of telecommunications and cabledistribution services is most effective in areas where the topology is favorable to terrestrial cables and where there is sufficient density of population to sustain the offering of a wide variety of services.

Summary and Policy Implications

This paper has presented three case studies where converging technology can be exploited to share costs in combined infrastructures. The level of cost savings achievable and the overall socio-economic benefit from exploiting the different convergent approaches vary depending on the specific country involved (due to differences in population, growth, density, geography, etc.) and the state of its existing telecom infrastructure.

CASE

I. WIRELESS (COMBINED CELLULAR, RURAL MICROWAVE, SATELLITE GATEWAY)

Key Benefit	Area of potential economy of scope
Support rural growth with cellular; stimulate international revenues.	Switching (urban, rural, international gateway); shared transmission and civil works.

II. POWER LINES (USE OF OPTICAL GROUND WIRE ON POWER LINES)

Key Benefit	Area of potential economy of scope
Access areas being electrified, remote from telecom network.	Shared trunk facilities; applicability most practical for new power line projects.

III. TELECOM & CABLE TV (COMBINED TELECOM AND TELEVISION ON CABLE)

Key Benefit	Area of potential economy of scope
Lower overall costs, stimulate new services, distance learning.	Shared backbone networks and local access facility; applicable for high population density areas and multiple services.

Developing countries can exploit these economies of scope, and maximize the social benefits of potential new service capabilities. This can be done by ensuring that appropriate policies, strategies, network plans, regulations, etc., are in place to stimulate alliances between service providers and/or the creative deployment of new technologies. The above models are in place, or are emerging, in certain countries. However, generalized models do not yet exist and each country should evaluate its particular situation in order to assess its ability to tap into the identified benefits.

Depending on the context, the following considerations could go into the development of policy alternatives:

- Competition amongst carriers and/or deregulation or privatization of certain services (data, cellular, etc.); this could encourage the innovative deployment of new technology by newcomers starting with a "clean slate".

- Adjust tariffs to stimulate new service growth and attract new investment, while providing subsidies for the poor population and encouraging penetration of telephones in rural areas, for example, through development of "teleservice centers" (centers housing telephones, computers, televisions, etc. for community use).

- Develop plans for specific areas of the country; for example, by targeting growth areas to discourage "country by pass" (where large companies deploy combinations of PBX and satellite systems to avoid using the domestic carrier facilities).

- Encourage development of human resource potential through training programs (in regulatory policy, technologies, engineering, management practices, etc.) to develop supporting local capabilities and spin-offs (e.g. engineering firms).

- Review organization of network and possible changes with new architectures exploiting convergent technologies (e.g. in many countries, all calls have to be routed via the PTT at some point).

- Implement spectrum management systems; ensure radio frequency availability for new services, which are also a source of revenue for the government through license fees.

- Examine ownership restrictions related to infrastructure for different types of services; consider lifting restrictions on types of services that can be offered by any given service provider.

- Review the regulatory regime and examine possibilities such as common regulation of telecom and broadcast services.

Exploiting the benefits of technology convergence can shorten the time to introduction of new information age applications of technology. It is important for countries to put policies and programs in place that build national competitive advantage and support development of the telecom industry and related services.

Authors

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- author of "Fiber Optics and Cable Television Business Strategy" book (1989),
- planning for the cable industry (network evolution, cordless phones, multimedia),
- business plans, market and technology studies for manufacturers and service providers,
- management of telecom infrastructure development projects in Latin America and Africa.

Johanne Lemay holds a Bachelors degree in Engineering Physics from Laval University in Quebec City and an MBA from Concordia University in Montreal. At Northern Telecom her achievements include creation of a major fiber optic multiplexer product line. She was also responsible for international marketing with a focus on the Pacific Rim, Latin America and Europe. She has been a consultant for the last 4 years; example projects:
- participation in the authoring of Canada's "convergence" report completed for the Department of Communications,
- business plans, and market evolution and technology studies in broadband and multimedia services,
- market development support for major manufacturers,
- regulatory and policy development support for the convergence issue.

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FIGURE 1

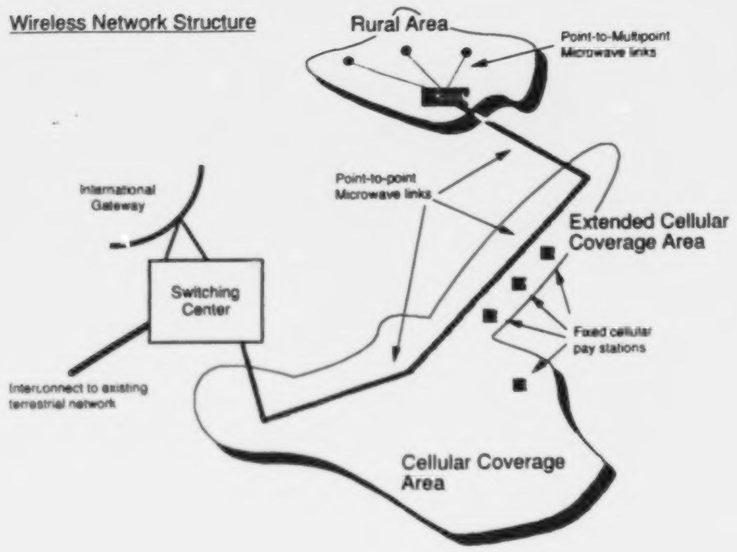

Wireless Network Structure
Rural Area
Point-to-Multipoint Microwave links
International Gateway
Point-to-point Microwave links
Extended Cellular Coverage Area
Switching Center
Fixed cellular pay stations
Interconnect to existing terrestrial network
Cellular Coverage Area

FIGURE 2

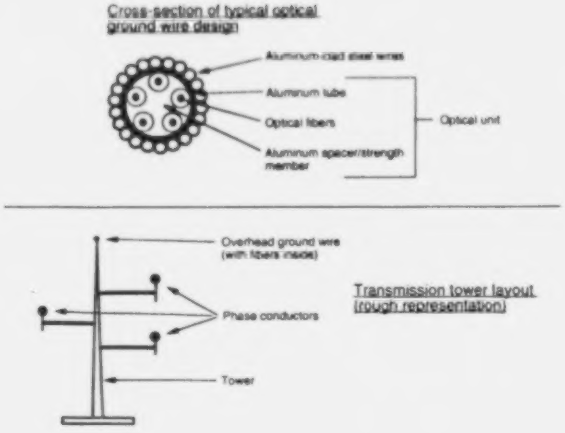
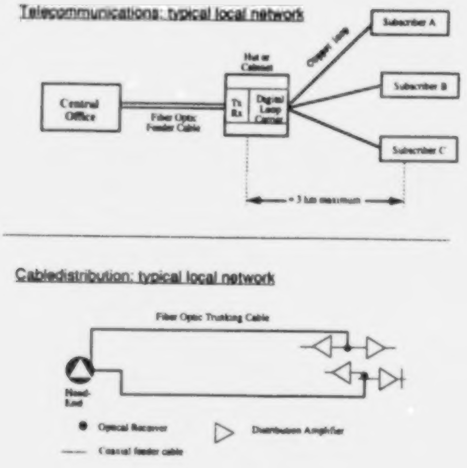

Cross-section of typical optical ground wire design
Aluminum-clad steel wires
Aluminum tube
Optical fibers
Aluminum spacer/strength member
Optical unit
Overhead ground wire (with fibers inside)
Phase conductors
Tower
Transmission tower layout (rough representation)

FIGURE 3


Telecommunications: typical local network
Central Office
Fiber Optic Feeder Cable
Hut or Cabinet
Tx Rx
Digital Loop Carrier
Copper Loop
Subscriber A
Subscriber B
Subscriber C
≈ 3 km maximum
Cabledistribution: typical local network
Fiber Optic Trunking Cable
Head-End
Optical Receiver
Distribution Amplifier
Coaxial feeder cable

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VALUE ADDITION ON POTS NETWORK FOR DEVELOPING NATIONS

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Problems faced by a developing nation in expansion of telecom network can be eased by adopting the value addition concept to Plain Old Telephone system. Franchising of STD service has seen benefits for customers as well as for service providers. Small EPABX, if used in similar fashion, can ease the pressure on capacity expansion for developing nations.

The importance of telecommunications and its effect on development of economy are beyond dispute. However, there is a large gap between the telephone density in developed nations and developing nations. We are here today to "Forge New Links" based on the "Missing Link", the Maitland report of the ITU's (Independent International Commission) on Worldwide Telecommunications Development prepared and published way back in 1984. After reading the report, I was really wondering whether we have moved at all during the last decade. My findings are based on following points :

1. Technology has moved further, but has not reached the masses in the third world countries.
2. Quality of service - disparity in developed world and developing world remains the same, barring a few exceptions like Singapore, Taiwan, Hong Kong etc.
3. Remote areas are still inaccessible.
4. There is an uneven distribution of service and facility in urban vs. rural area.
5. Equipment is getting better, but cost is also rising very fast and shortage of capital prevents developing countries from catching up with the rest of the world.
6. Rural areas are neglected in developing countries because of non-remunerative call pattern and lack of equipment which can sustain adverse climatic conditions.
7. Lack of trained manpower to work in remote areas.

Against this background, which shows no major change in the situation, the future seems not too bright. But the question is, can this be changed? Can the PTC94 gathering give a new direction to ITU and cooperate at an international level to give benefit to users of telecom services all over the world? Can PTC94 conference show the manufacturers and service providers (who have invested billions of dollars and are waiting for return on their investment), how can developing countries be linked to the developed countries without collision ?

My answers to these questions is YES. But this is not possible with the same old traditional ways. These have been tried for last 10 years but have not shown very encouraging results as far as the pace of progress is concerned.

Let us glance at these traditional methods. We have been trying to meet the demand of basic telephone service by increasing the capacity of the switch and thereby of the network. The developing countries are lagging behind and meeting the demand seems like a mirage. The large switch puts a very heavy burden on finances of any developing country, because this is a capital hungry equipment. In my country, we have been hearing every year, for the past 20 years, that telephone will be available on demand in next two years. Providing basic service itself is a problem for many developing countries and this becomes a chicken and egg syndrome. Only a non traditional approach can resolve this problem. India has experimented on a solution and I feel it is worthwhile for others to follow and reap the benefits from this experience.

I am presenting the same as case study.

The problem of making telephone service available was converted into making it accessible to start with. Similarly, a concentrated effort was made in designing a small switch, which could operate without any problems in rural environment (working without any climate control) and which would cost less. The requirement in smaller places was always less and demands could be fulfilled in stages. With such development, the rural subscriber is able to talk to any person in the global networks, while it is a difficult thing for a city subscriber who is still on old strowger/ cross bar exchanges. This also gave confidence to the service provider to install state-of-art technology exchanges in rural areas first and clear the long standing waiting list.

The second area needed to cover accessibility was in the urban areas. Payphones is a standard solution for this, but the world over, payphones face a lot of problems and India was no exception. They are subjected to vandalism. In developing / under developed countries, this problem is acute due to low educational level, lack of social consciousness and high unemployment. There is a heavy damage to the public property. It was therefore decided to offer these phones on a franchised basis. The standard technology was, to use coin or newly developed card telephones. Initially, there were no takers to this scheme introduced by the Department of Telecommunications. Franchisées had no experience in this type of business as well as quantum of business. The rules were also not very encouraging. The cost of equipment was very high, number of operating points per franchise were very high. Simultanenously, the department was providing this service with a different kind of machine, based on microprocessor technology and providing better call information to the user of service. This was essential as user had very little faith in the system at that time. Initially, these machines were installed on an experimental basis and based on results, it was decided to amend the rules, which resulted in heavy demand from franchised operators to operate such booths. It is now possible to make calls to any place in the country as well as all over the world from almost any place within 10 to 15 minutes. Just about four years ago this time was 10 to 15 hours and in some cases it was days.

The franchised STD Public Call Offices (PCO's) has shown

1. User accessibility to telephone within 200 mtrs in a city as well as smaller towns which was once 5 kms in city and 50 kms in rural areas.
2. Development of entrepreneurial spirit among the citizens and has created employment potential.
3. Growth in telephone call revenue for Department of Telecommunications - the service provider. (See Annexure D)
4. Service not subjected to vandalism as safety is the responsibility of entrepreneur.
5. Tamper proof machine imparts reliability and confidence for the user.
6. Growth of manufacturing industry for these machines. With the opening of market and demand projected for next 5 years by the Government, there are now 40 manufacturers as against 2 when the orders were expected only from Department of Telecommunications. This has benefited electronic components industry, service industry and dealers and it has become a separate industry by itself.

There were a few problems on the way. But these were overcome and the system is now almost established. Any other developing country which wishes to follow this path should look at this solution from a long term view and plan a systematic growth with clear cut goals in minds. It need not worry about the success of the scheme. Since I was associated with this scheme right from the beginning, and based on my experience. I am now suggesting a **VALUE ADDITION SERVICE ON POTS. (PLAIN OLD TELEPHONE SYSTEM)**

The telephone service can be now distinctly divided in two classes. One is business class and other residential class. For business class it is a resource and for residence it is a consumption item and hence it is a cost. Because of socialist approach by most of the developing countries, the true cost of telephone service was not passed on to the residential subscribers. Alternately, they were kept away from getting the service because it was not possible for governments to bear the subsidy. This has resulted in a long waiting list for telephone in most of these countries. With the facilities a telephone can provide, the demand has always grown in much larger proportion than supply. Traditionally, the same solution is being tried viz. to increase switch capacity. But it is also true that, residential lines do not generate the kind of revenue a service provider expects. The revenue generated is far less than the cost of capital required to set up and maintain a line. This cost is ultimately borne by the nation.

I am suggesting use of a franchised scheme, based on STD PCO's described earlier. This scheme is **"Group EPABX"**

PROPOSAL

My proposal is that the PTT's should franchise Group EPABX scheme like STD PCOs. The PTTs should rent out specific number of lines to an organization or individuals and they in turn will rent them out to the end user at rates specified by the PTT. The scheme should be made applicable in large residential societies/buildings where exchange line load is not substantial. There should be two categories of connection. One is Business connection and other is residential connection. All *residential connections in that area should be routed through* Group EPABX scheme. A DEL may be provided in residence but the same should be considered as a business class.

The franchisee could invest in DEL deposit, EPABX equipment with suitable metering facility, internal wiring, telephone instruments and operator till DID (direct-in-dial) facility is provided. He should be allowed to expand to a fixed number of customers but not a very large number, otherwise service may be hampered in the initial stages. PTT should regulate on charges to be collected towards capital cost in the form of fixed monthly or yearly service charge, plus actual call charges which should be commission payable. The rates may vary from country to country as well as demand and supply position. I anticipate, that the following objectives can be achieved :

1. Demand supply gap will reduce and be ultimately eliminated.
2. Less burden on PTT's to cater to large customer base.
3. Franchised operation will reduce burden on capital cost to PTTs for putting up Direct Exchange Lines.
4. Reduction in base of customers to be serviced by PTT, as it will serve only franchised operators in residential areas and not individual customers.
5. Increase in revenue on Direct Exchange Line (DEL) from residential line, as they may be in the ratio of 1 : 10.
6. Value added service can be provided from Group EPABX scheme computers.

The residential customer will benefit in the following ways :

1. Instant telephone connection.
2. Free intercommunication within the group
3. Better service from franchised operator.
4. Access to more than one Direct Exchange Line without paying for it.
5. Instant detailed bill for calls made

CONCLUSION

Thus, with the introduction of Franchised Group EPABX scheme, the PTT's can have full control on operation, serve more number of people without increasing their overheads and be able to collect large amount required for expansion without any interest burden. Most of the governments in developing countries wish to increase job opportunities. Simultaneously, there is a drive to privatise most of the public sector, because public sector may not function with the same efficiency after a certain stage. Franchising will create more entrepreneurial spirit among the nations. The competition will see a healthy growth of this business and also serve the cause of better service to the society, which is the primary objective of any government. In most of the third world and developing countries, Governments regulate the distribution of Petrol, Diesel and LPG through distributor/dealer network and monitor their entire activities. Then, why is it not possible to distribute and operate Telecom facility, too ?

The success depends upon innovative approach and thinking.

Out of the two schemes described above, STD PCO's is a tremendous success in India. The other one is not yet implemented but can prove likewise, in achieving the object of telecom accessibility. These methods can be most appropriate for countries like Afghanistan, Bangladesh, Bhutan, China, Pakistan, Sri Lanka, countries in South African Continent and Latin American Countries.

The enclosed annexures (A-D) give figures on costing, earning by franchisee and other benefits. They are related to Indian conditions but individual countries can base their models on similar lines.

ANNEXURE : A

COSTING OF GROUP EPABX BASED ON 16X96 C-DOT EXCHANGE

A. CAPITAL COST		(In Rupees)
1. Cost of Main Exchange with 90 instruments, installation and suitable UPS		4,60,000.00
2. Cost of Cabling (75 m x 90 Ext x 12/-per m)		80,000.00
3. Cost of Call Accounting system with Computer Printer and MDF		1,00,000.00
4. Cost of DEL (10 lines @ Rs.8,000 each)		80,000.00
	TOTAL	7,20,000.00
Capital cost per month per tenement on 10 year use and interest @ 18% per annum		145.00

B. OPERATIONAL COST (per month)		
1. Cost of operators (6nos on 24 hrs duty)		6,000.00
2. Cost of Maintenance (1% of Capital cost)		7,200.00
3. Cost of 10 DEL rent		1,000.00
	TOTAL	14,200.00
Operational Cost per month per tenement		155.00

FIXED COST PER TENEMENT PER MONTH

Total cost A + B	300.00
Add 5% misc expenses charge	15.00
Add 10% service charge as profit for operator	30.00
	345.00

A preliminary survey made gives a clear indication of customer acceptance to this price, as he gets immediate telephone connection, plus the benefit of free intercommunication within building area, as well as other advantages of electronic PABX. Flat call charges will be additional incentive to the user.

ANNEXURE: B

GENERATION OF FUNDS

1. Estimated waiting list is 3 million

2. Estimated booking under general category 1.5 million

3. If general category is abolished (by introducing Group EPABX scheme) it is estimated that 50% will opt for full payment of Rs.15,000 and 50 % will ask for refund resulting a net cash in-flow of Rs.13000/- for .75 million subscribers i.e. **Rs.9.75 billion**

4.1 Call generation per residential line at present is generally 250 to 300 call per month which means it generates a revenue of **Rs.2,160/- per year**
(600 bimonthly calls minus 150 free calls multiplied by 0.8)

This revenue is gross under-utilization of Capital employed.

4.2 In Group EPABX single line can be utilised by 10 tenements and likely calls made will be 250 (lower average is assumed) per month and 30,000 per year.

4.3 To encourage people to join Group EPABX the rate should be flat @ 0.80 per call and commission of 20% (Rs.0.16) be paid to the service provider. Even at this low slab revenue per DEL per year will be 30,000 x 0.64 = **Rs.19,200 per year** which is almost ten times the present generation.

4.4 Besides this, overheads to the department will be much less as their responsibility of maintaining lines and subscriber premises equipment will be curtailed, complaints of excess billing are not faced directly and will be negligible.

5. One Group EPABX of 1000 lines, if released, in any city, can bring down the waiting list by 10,000 subscribers if a ratio of 1 : 10 is maintained.

6. Business community should be encouraged to increase the use of value added services by giving a flat rate for usage to increase the capacity utilisation.

ANNEXURE:C

Job Opportunities

I estimate about 500 societies in a city like Pune, which has a population of 2 million, where Group-EPABX could be installed. A single operator can manage at least two units efficiently. Thus 250 Entrepreneurs can be created and they, in turn, can create job opportunities for 3000 operators in the city of Pune alone. Metro cities can have larger potential but in all, 100 district places on an all India basis can be covered under this scheme. The increased turnover and pick up in demand for EPABX can indirectly boost service and other infrastructure opportunities and it will have sizable impact on the entire economy.

ANNEXTURE:D

STAEMENT SHOWING IMPROVEMENT IN REVENUE PER DEL (Direct Exchange Line) AFTER INTRODUCTION OF STD PCO IN PUNE TELECOM DISTRICT

YEAR	DEL	NO OF PCOS	% TO DEL	PCO REV RS. (MN)	REV/PCO RS.	REV/DEL RS.	% OF TOTAL
1989-90	79,000	16	0.020	5.119	319,938	9,100	0.71
1990-91	91,000	124	0.136	22.519	181,605	10,400	2.38
1991-92	107,000	330	0.308	58.410	177,000	10,600	5.15
1992-93	121,000	658	0.544	127.454	193,699	11,200	9.40

CAN TELCOS DELIVER SHAREHOLDER VALUE IN THE DEVELOPING WORLD?

Lawrence Kenny and Graeme Clark
Coopers & Lybrand
Atlanta, Georgia & London, England

The session will analyze the issues surrounding the expansion of telecommunications infrastructures in developing countries from the perspectives of governments and investors. Initially we will review foreign investment in developing countries.

Four principal vehicles for investment:

- Telco privatizations
- Cellular
- Competing networks
- Cooperative ventures

How much has been invested to date (see Figure 1).

Cellular is by far the most available type of deal, however, many cellular franchises have now been awarded and remaining opportunities are limited.

Telco privatizations have been highly successful to date, especially in Latin America and Southeast Asia where significant shareholder value has been created (see Figure 2).

Privatization has brought significant improvements in quality of service and efficiency also (see Figure 3).

While many developing countries have licensed cellular networks and have either privatized, or expressed a wish to privatize, their telephone company, few have licensed second network operators:

- New Zealand;
- Malaysia has expressed its intention to;
- HK has expressed its intention to; and
- Mexico in 1996.

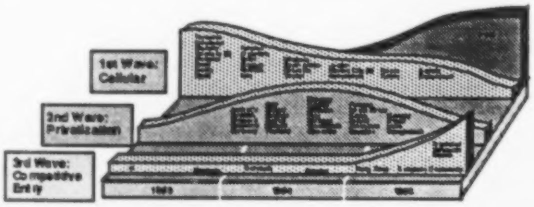
Cooperative ventures can take many forms from simple consulting advice to build-lease-transfer arrangements to parallel networks.

These types of arrangements have certain attractions from both the perspective of the country and for investors. From a country standpoint, assets are less likely to be deployed uneconomically and the incumbent telco (often a significant source of government revenue) is less likely to be harmed. From an investors standpoint, BLTs and other such investment vehicles offer a degree of certainty about returns.

While most developing countries have received some form of consulting advice from developed telcos, other countries have used various investment vehicles to attract foreign capital.

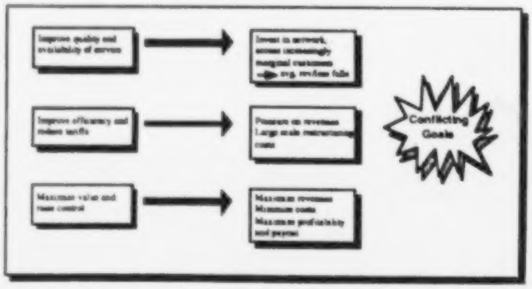
- Thailand - TelecomAsia: 1 million line franchise in metro Bangkok. Investors included NYNEX and 1 million rural line franchise awarded to NTT.
- Indonesia - Parcels of 10-50,000 line contracts awarded on BLT basis to a number of investors.

Many developing countries have expressed their intentı to privatize their telco in order to raise cash and improv service.


1st Wave: Cellular
2nd Wave: Privatization
3rd Wave: Competitive Entry

The drivers of privatization and the desire to introduce private capital in to the provision of telecommunications are threefold:

- Improve quality and availability of service;
- Improve efficiency and reduce tariffs; and
- Raise cash ....


Improve quality and availability of service
Invest in network, attract increasingly marginal customers
avg. revenue falls
Improve efficiency and reduce tariffs
Pressure on revenues
Large scale restructuring costs
Maximum revenues
Minimum costs
Maximum profitability and payout
Conflicting Goals

.... however, they do present certain conflicting goals, and it is the role of regulation to resolve these conflicts and ensure that both Government policy objectives are met while offering investors enough incentive to commit capital.

In attracting private capital to the sector, governments have several policy tools they can employ to incent investors, and curb monopoly rents:

- Ownership structure;
- Regulation and tariffs; and
- Competition

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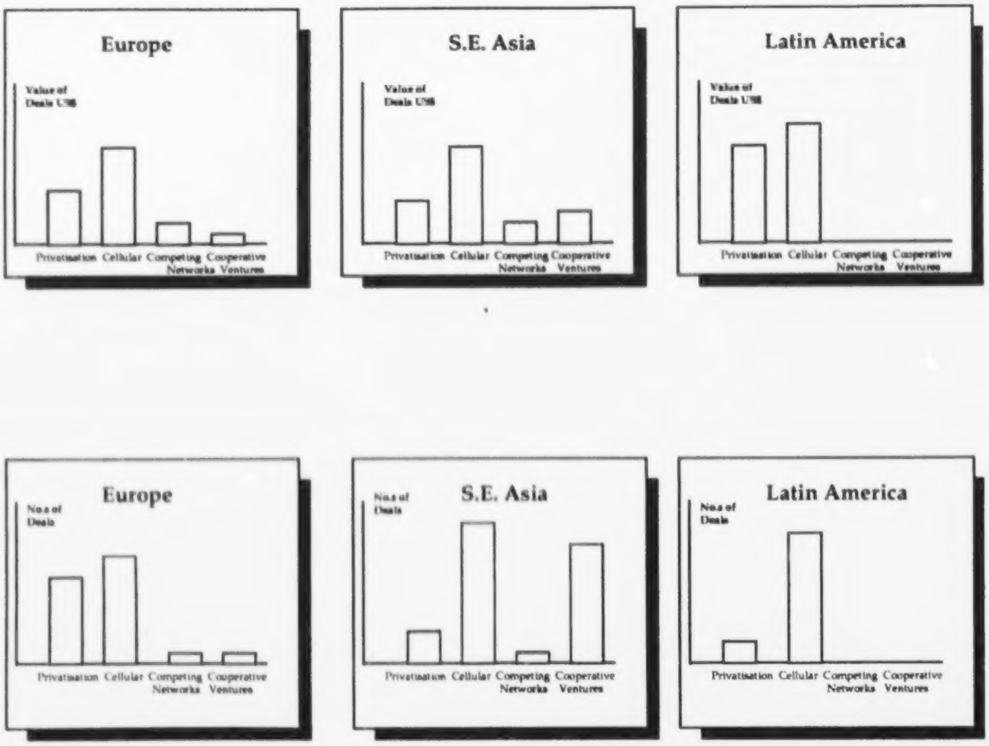
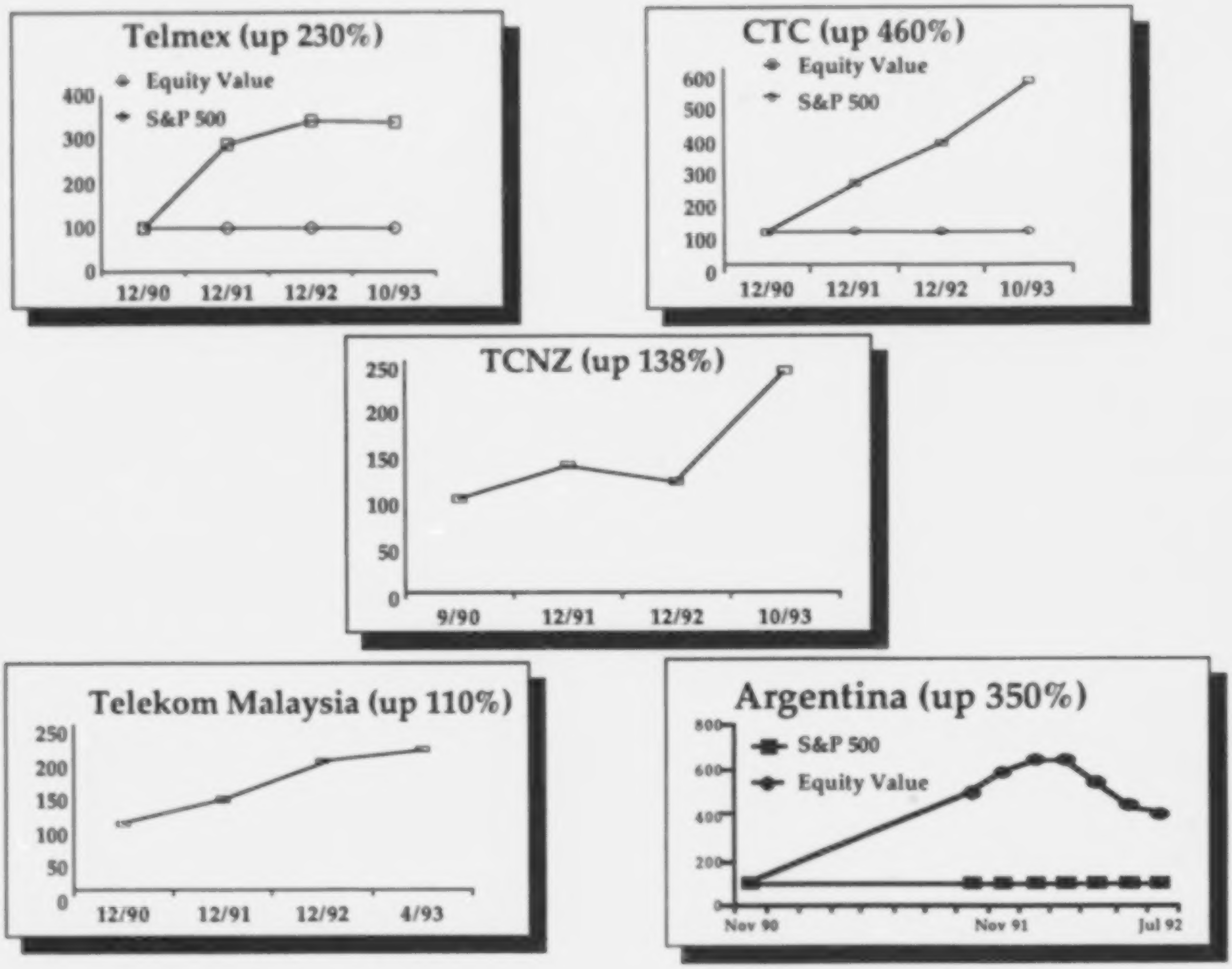
Figure 1

Investment to date



Note: These are illustrative figures only

Figure 2


Telmex (up 230%)
Equity Value
S&P 500
400
300
200
100
0
12/90
12/91
12/92
10/93
CTC (up 460%)
Equity Value
S&P 500
600
500
400
300
200
100
0
12/90
12/91
12/92
10/93
TCNZ (up 138%)
250
200
150
100
50
0
9/90
12/91
12/92
10/93
Telekom Malaysia (up 110%)
250
200
150
100
50
0
12/90
12/91
12/92
4/93
Argentina (up 350%)
S&P 500
Equity Value
800
600
400
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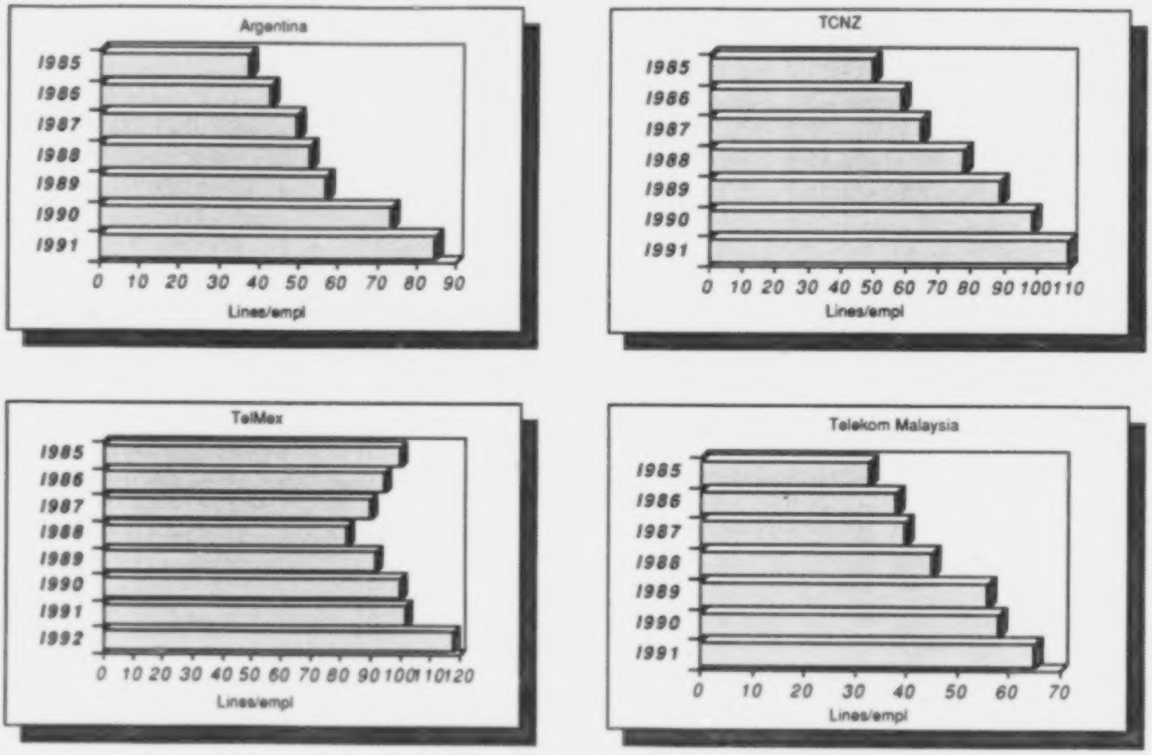
0
Nov 90
Nov 91
Jul 92

Figure 3


Argentina
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TelMex
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Lines/empl
Telekom Malaysia
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1991
0 10 20 30 40 50 60 70
Lines/empl

Ownership Structure

Ownership structure can be viewed from two perspectives:

- ownership and control
- sector structure

Many governments have chosen to privatize their country's telco in part only, with few exceptions, all countries have retained a so-called "golden share" which retains special rights and powers of veto. Most strategic investors have required management control, even though they may not have acquired equity control. By gaining management control, having some element of certainty through a regulatory framework to govern the sector, strategic investors have the ability to plan and implement strategies which unlock the value of the telco.

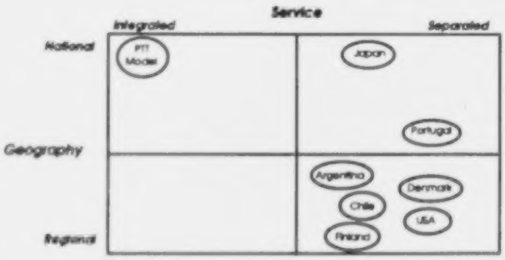
Many governments in developing countries have restructured the telecoms sector prior to the introduction of private sector capital. Typically this involves the separation of regulatory and operational functions and less commonly the structured separation of the operational functions of the telco either along geographic or service based lines:

By this we mean:

- A division on geographic lines: where companies provide local (and sometimes long distance) service in a defined region; and
- A division on service lines, such as between local, long distance and international services, with two or more companies operating a particular service for the whole country.

The figure below illustrates a number of models which have been adopted around the world.

Example Structural Models



The characteristics of the industry structure and a desire that basic services competition should be introduced eventually, mean that the incumbent operators structure is crucial in determining the future competitive landscape of the industry. Essentially, we need to consider the options for operator structure both in terms of how they will facilitate the emergence of sustainable, economic competition at an appropriate point in time and how they will appeal to potential investors.

Regulation and Tariffs

The prime focus of regulation within the telecommunications sector worldwide is to instill the facets of a competitive market into a sector which is dominated by incumbent telcos, i.e.:

- efficiency;
- market based pricing;
- choice;
- quality;
- innovation;
- economic returns on investment; and
- rational market behavior

Historically, telecoms provision has been the preserve of state monopolies. Reversing this situation with the introduction of competition is close to impossible without some form of regulation to protect new entrants.

The overwhelming mechanism for regulating the prices and efficiency of the sector is price-cap regulation. Through the manipulation of the price cap regulators can incent incumbent telcos to increase productivity and rebalance prices.

Within the developing world (and in many developed telcos) prices are significantly out of line with the underlying costs of service provision. Often rebalancing of tariffs may be at odds with sector policy objectives of increasing the availability of service, as rebalancing usually results in significant and sustained increases in access tariffs (connection and rental). However, many developing telcos use access tariffs to control demand by requiring significant security deposits and high connection fees. A similar principle is applied to international calls, where tariffs are substantially in excess of costs. In some cases the objectives are two fold:

- control demand for outgoing calls; and
- stimulate inbound traffic and accounting rate receipts.

As a long-run aim, Regulators should be trying to manage themselves out of a job by introducing competitive disciplines into the sector and ensuring a level playing field for all participants.

Competition

While competition in telecoms basic services is not widespread within the developing world, it is showing signs of emerging:

- Malaysia
- Hong Kong
- Mexico, post 1996

Typically, prior to the introduction of competition, networks have been developed to a mature status with the protection of exclusive rights. This has allowed operators to expand their network to a point where they can realize economies of scale, usually by subsidizing network access through usage rates. In a competitive situation cream-skimming prevents this subsidy unless interconnection rates are used to manage the process. Where interconnection has been used to sustain inherent cross subsidy (e.g., the USA, and more recently in the UK) the outcome is typically an adversarial process with continuing regulatory uncertainty. It involves considerable regulatory intervention of a detailed technical nature.

The ease with which competition can be introduced into different segments of the market for basic services will vary according to specific market characteristics, including:

- entry costs due to economies of scale and scope;

- total segment size;
- traffic flows (and underlying financial flows);
- efficient supply costs and their relationship to tariffs; and
- wealth.

Many underdeveloped economies do not lend themselves readily to the competitive provision of telecommunications, however, as these economies grow and prosper the opportunity for the introduction of competition becomes greater.

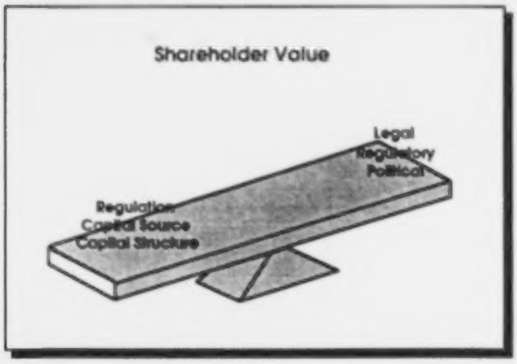
The Introduction of Competition - Alternative Networks

The economics of full PSTN competing networks are typical of greenfield infrastructure projects: substantial up-front capital expenditures and lengthy paybacks with strong free cash generation thereafter. This requires extra financial planning certainty in the lengthy period to breakeven and beyond (see Figure 4).

Competing networks face substantial business as well as country risk. This requires an ongoing proactive government stance in favor of competition beyond those required to counter political/economic uncertainty.

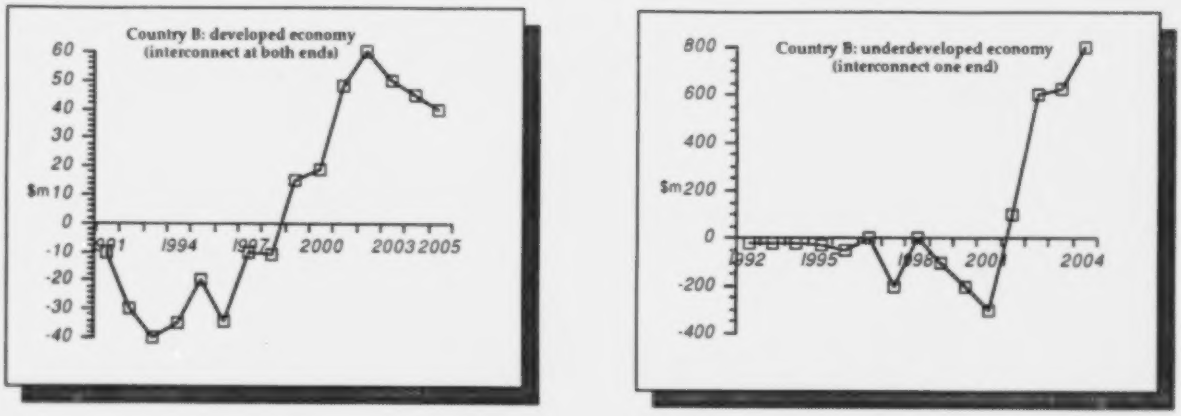
Southeast Asia is projected to be the fastest growing region economically in the coming decade, it presents investors with some extremely interesting investment opportunities in both privatizations and competing networks. Many cellular franchises have already been awarded, though digital cellular and personal communications networks (PCN/PCS) licenses are now being considered for competitive auction by many governments.

The forecasted economic growth of the region, combined with the relatively low level of telecoms penetration should act as a magnet for investors. For governments the challenge is to develop comprehensive plans focusing on the legal and political position of any prospective investors to ensure that systematic risk is reduced. A regulatory framework which introduces certainty into the relationships between the different stakeholders in the sector is a prerequisite to any such strategy.



For investors the challenge is to creatively plan and structure financing to take full account of risk, and developing entry strategies to minimize risk through negotiating rigorous regulatory frameworks and capital structures.

Figure 4



A	Financial Profile	B
$25k	**GDPpc**	$3k
$0.7bn	**Cum Capex**	$2bn
12%	**IRR**	32%
12 Years	**Payback**	10 Years
$0.5bn pa	**Yr 10 Rev**	$1.5bn pa

CAN DIGITAL KIOSKS FOR TRAVELERS BRING DIGITAL SERVICES TO THE LOCAL LOOP AND MAKE A CITY, OR VILLAGE, SMART? A DEVELOPMENT STRATEGY

By
George E. Darby, J.D., M.B.A.
Law Offices of George E. Darby
President, Information Technology & Travel Industry, Inc.

Abstract. Local exchange carriers and other telecom service providers in cities that host telecom-intensive operations of multinational corporations have comparatively little worry about justifying the expense of upgrading those cities' end-office and tandem switches to advanced digital switching technologies. The multinational corporations in those cities have moved past ISDN: in the U.S. they demand, and are getting, bandwidth-on-demand technologies like ATM. In cities without multinational operations and in suburban and rural areas, demand for the digital local loop by less sophisticated users defies prediction; a telecom service providers' cost-justification problem is correspondingly much more difficult. This paper examines a telecom development strategy that uses virtual office and travel information services to extend the benefits, and demand, for digital network access to such "low demand" areas. In these low demand areas, digital kiosks can be the axons that expose the populace to information technology and transform a slumbering city to a smart city.

The Smart City Defined. In a smart city lives an information society. A smart city is the vessel that contains a workforce that uses information technology to add most of the economic value to the goods and services that originate in that city. A smart city can make smart washing machines, communications satellites, or information-enriched vacations. A smart city has a physical infrastructure and regulatory environment that permit and promote the development and exchange of information with minimal transaction costs.

Physical infrastructure boils down to adequate conduit systems underlying every street and throughout each building: conduits for local exchange carriers, conduits for cable television system operators, conduits for other telecom carriers, and conduits for municipal and building signaling and control (e.g., traffic lights and hazard warning displays, energy management, and vehicle monitoring).

The regulator of information service providers in a smart city, at least in locales that have shed the franchised monopoly concept, will be market forces, open competition. Can a smart city exist where there is a telecommunications provider monopoly or high business capitalization startup requirements? Probably not. Such regulatory barriers to business entry will shift the birthplace of innovative information services to more competitive locations. In addition to telecom regulation and startup capitalization requirements, there are other transaction costs that a smart city minimizes or eliminates. Chief among these are security of information and authentication. Smart cities will have laws that punish the misappropriation of information, and laws that set standards for the security of information warehouses, access to information, and authentication of users. Just as today's laws carefully describe and punish the theft of personal property, and license contractors, professionals, and public facilities, tomorrow's laws will carefully describe and punish the theft of intellectual property, and license information service bureaux. An information service provider startup should not have to worry any more about the security of its data when it contracts for storage and processing than we worry today about the safety of valuables put in a bank safe deposit box.

In the future, there will probably be less distinction among today's "classes" of carriers and more distinction in services tailored to customer classes. Stated differently, there will probably be a shift from "local/interexchange carrier" thinking to value-added service providers for vertical industries; for instance, hospitality industry service providers that provide voice, video, data, and image transmission and services for hotels and other travel service suppliers. The disappearance of "classes" of conduits, wireless systems, and common carriers, and the higher visibility of value-added, "vertical industry neo-carriers" that use a variety of transmission systems and providers will be one of the defining attributes of the smart city. Today, no one cares which data network their e-mail travels over; soon, no one will care which digital network their voice and video travel over, either. The users' focus, and consequently the service providers' marketing focus, will shift to how well a set of value-added services (services beyond merely setting up a voice circuit, including such services as voice mail, speech to text file conversion, automatic database generation based on ANI, etc.) match the needs of a vertical industry. Perfect performance of the underlying digital network will be assumed.

"In a smart city lives an information society." More important than the physical infrastructure, regulatory environment, and intellectual property laws, however, is the information technology IQ, the IT literacy, of the society. Without users, there is no demand for services. How, then, can "low demand" areas, especially the developing areas in the Pacific Basin and Asia, create demand for digital services? How can "low demand" areas germinate and grow smart cities? By planting smart villages, as we shall see.

Information Technology Convergence and the Traveler. To date, local exchange carriers and other telecom service providers that have deployed ISDN-capable switches have had great difficulty convincing anyone but multinational corporations to subscribe to ISDN, much less to adopt more advanced, "bandwidth on demand" digital services. Yet, the telecommunications and computer industry trade press, and increasingly the general business trade press, is full of glowing reports on the bonanza to be had in delivering interactive multimedia to residential markets. There appears to be an immense, and growing, gap between actual consumer demand for digital services and vendors' perception of that demand. Will digitally compressed movies on demand from neighborhood video servers, interactive virtual reality games, and three-dimensional home shopping usher in the era of terabytes to the pedestal, megabytes to the home, and explosive growth of digital networks? Or is there an intermediate step in the transition to digital local loops for which a better business case can be built? Of particular interest is a "digitalization strategy" appropriate for Asia/Pacific Region.

The central premise of this paper's digitalization strategy is that information network providers and information service providers should examine the information needs of the most information-hungry individual of all, the traveler. The daily information and entertainment needs of a traveler are typically multiples greater than those of an average residential consumer. These information needs, and selling opportunities, include daily necessities, dining, day and evening attractions, games, maps, ground services such as excursions, language translations, emergencies, financial services, insurance, travel reservations, shopping, and delivery of purchases to the hotel room, traveler's home or office, or other location. Better yet for the telecom service provider, travelers are geographically concentrated in districts that have: accommodations, whether high-rise hotels in Singapore or cottages in the Cook Islands; attractions, like theme parks or restaurant districts; and transportation, like airports and railroad stations. It's far more likely that business and leisure travelers will pay for information, entertainment, personal services, and teleshopping on a daily basis and do so in a more manageable geographic area as compared with widely dispersed residents who have drawers of maps, a lifetime of knowledge about local restaurants, theaters, stores, and sightseeing, extensive videocassette libraries or CATV service, and regular visits to favorite vendors.

Hotels: Misguided Profit Motive. The most significant marketing barrier to the scenario painted above is the traveler's access to the appropriate information appliance. The most desirable place of access to entertainment digital services from the traveler's perspective is the traveler's hotel room or other accommodations; for information services, the best place of access is the hotel room, as well as elsewhere in the accommodation property, or at attractions and transportation facilities. Hotel owners have historically been uniformly and adamantly opposed to the introduction into guest rooms of entertainment and information services that the hoteliers do not control. Hotels typically operate proprietary cable television systems within the hotel, complete with pay-per-view channels. By limiting guests' access to information, hoteliers reason that guests will spend more money at the hotel's own dining, entertainment, and excursion vendors. In reality, the highest non-business priority for many, if not most, guests at non-resort hotels is to identify and patronize attractions outside the hotel. Budget conscious travelers even conduct this process of identification at payphones rather than at guest room phones.

Hotels are also the "far-right" (very conservative) in travel industry automation. Airlines long ago moved to boarding passes that permit travelers to appear at the boarding gate, present the pass, and board the aircraft. Rental car companies have emulated this trend: present your "boarding pass" on the vendor's shuttle bus, receive your keys, and be dropped off at the assigned car. Hotels who are listed in the same computerized reservation systems as airlines and rental car companies, could long ago have implemented a "boarding pass" system in which the guest presents a boarding pass on a shuttle bus or to an onsite clerk and is issued room keys. The first hotels to implement a boarding pass system and to discard the "tradition" of making guests stand in line to check in (and in the most techno-void hotels, check out) will immediately garner much new business. Likewise, the first hotels to permit third-party digital services to guest rooms will attract many deserters from hotels that continue to offer only proprietary cable TV systems. The hotels that permit third party information services in guest rooms would normally have contractual arrangements with the information service provider to receive commissions for sales of goods and services to the guest. Wireless delivery of information services to notebook computers in hotel guest rooms would circumvent wired delivery of both services and hotel commissions, but only road warriors will have the resources to use wireless delivery.

Third party digital services in hotel rooms will provide not only information and entertainment to the guest, and profits to the hotel, but will better support the "virtual office" system upon which all multinational corporations now depend. The guest room information appliance would access a digital network. Such digital network access should enable the guest to establish communications sessions with computers in the guest's home office or at other packet- or circuit-switched terminal locations. This digital connectivity would often not be available at hotel payphones. Through such digital sessions, the guest could videoconference, receive e-mail and imaged documents (such as faxes), and generally conduct the usual business done in a virtual office. The information appliance could also access local printers and ticket delivery machines, so that documents, including travel documents, could be printed and retrieved on-premises. Such support for business travelers goes far beyond that provided by "business centers" in hotels, and would attract new clientele. Such guest transactions could generate commissions for the hotel that would far surpass revenue from POTS service and pay-per-view cable television.

Travelers and the Digital Kiosk. For security, comfort, and work environment reasons, hotel guest rooms are arguably the best location for deployment of digital information appliances. The failure of hoteliers to appreciate the relevant economic and technological trends may delay or even prevent the introduction of such services in hotel guest rooms. The alternative locations for digital information appliances for travelers are in non-hotel accommodations and in kiosks in areas frequented by travelers. Smaller hotels that now provide guests with third-party cable television, and non-hotel accommodations such as B&Bs and rental condominiums, could attract clientele from larger hotels by offering guest room or lobby digital information appliances. Standalone kiosks, which I call "digital kiosks," could provide the same support for virtual office services as information appliances in guest rooms, but with somewhat less comfort, security, and working room for the traveler.

To satisfy business travelers, a digital kiosk should take a form similar to today's "snapshot" kiosks: the kiosk should have adequate lighting and folding doors that can be closed for acoustic isolation (the lower half of such doors may be transparent for security reasons). Such a digital kiosk would be a virtual office, and ideally would contain a high-res monitor or display panel, video codec, speakerphone, fax, and laserprinting facilities. Charges could be assessed based on the facilities, time, and data transfer used. Whether in hotel rooms, airport lobbies and lounges, remote resorts, or kiosks in areas of traveler attractions, there is arguably already a market for digital services for travelers whose employers or clients use ISDN or bandwidth on demand networks for image services and computer integrated telephony. Most airports in Japan have ISDN payphones with both analog and digital jacks. The day will soon come when we will see a traveler awkwardly videoconferencing with a notebook computer at such an airport lobby payphone. That traveler will be uncomfortable indeed if his "meeting" is open to curious bystanders.

The digital kiosk could serve double duty as a multimedia travel product sales booth, complete with a ticket delivery machine. The traveler might be able to trade frequent flyer miles for digital kiosk time. In addition to its virtual office role, the digital kiosk could deliver access to things common to business and leisure travelers: daily necessities, dining, day and evening attractions, games, maps, ground services, language translations, emergencies, financial services, insurance, travel reservations, shopping, delivery of purchases, etc.

The Development Strategy. A digital kiosk, or digital appliance in a guest room, would serve the immediate purpose of extending digital services to areas where such services can not now be cost justified. The digital circuit serving a digital kiosk could be a foreign exchange line to the nearest switch with the appropriate digital line card and software, or it could be served by VSAT. VSAT introduces an undesirable delay in some applications, but in remote areas this delay would certainly be tolerated compared with the alternative of no digital services.

Digital kiosks and information appliances would have an important collateral benefit: increasing awareness of digital services by those most able to afford them, business and leisure travelers. Travelers from rural areas who used multimedia facilities in hotel rooms or digital kiosks would at least understand what digital services can provide, which would help to create aggregate demand. Travelers on business who saw competitors using digital kiosks as virtual offices are likely to be very vocal upon their return to their home office about their disadvantage versus their digitally enabled competitors.

Whether digital connectivity is provided terrestially or by VSAT, digital services tailored for business and leisure travelers and delivered to guest rooms and digital kiosks present a promising strategy for the cost-justifiable introduction of digital services in areas with hard-to-quantify service demand. More importantly, digital kiosks would also be available for use by the entire population, and not just for business and entertainment use. School systems might issue usage credits to students that would activate kiosk services at certain hours. In areas where there were inadequate schools, instructional materials could be delivered either inside the kiosk in real-time, or downloaded to storage or display devices. Access to a single digital kiosk, subsidized by travelers, could raise the IT literacy of an entire village or island.

With the advent this year of VSAT service covering the entire Asia/Pacific Region, the digital kiosk development strategy is no longer a pipe dream, it's a matter of integrating off-the-shelf components. In the advanced countries, we now focus on smart cities, ATM, and fiber to the desktop. Outside the West, smart villages with a mere 64 Kbps link each are probably more important than a smart city. Smart villages would retain their residents and stem the urban migration that disrupts the economies of many Asian countries. Smart villagers, and their visitors from abroad, could telecommute to employers headquartered in the cities. The combination of education through travel and education through traveler-subsidized digital services would benefit both visitors and the visited. To deliver the services, many domestic and foreign "vertical-industry neo-carriers" would be created and sustained.

The members of PTC can play a leading role in bringing the global digital network, smart villages, smart cities, and an information economy, to "low demand" areas of the Asia/Pacific Region. Business and leisure travelers, coupled with digital kiosks, can generate the capital required for that transformation.

The Role of Telecommunications in the Developing World

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Abstract

It is in the best interests of developed countries to assist their less developed neighbours in an attempt to introduce a more equal distribution of communications systems worldwide. Developing countries can learn from the efforts of their more advanced neighbours and effectively leapfrog their economies into the new communications age. All it takes is a little patience, a lot of planning and a whole lot of "vision".

Introduction: "The Missing Link"

Back in 1985, the report of the Independent (Maitland) Commission of the International Telecommunications Union, The Missing Link, highlighted the plight of developing countries which do not have even elementary telephone service in many regions, and in the cities labor under inadequate, inefficient and old-fashioned services, and stressed how this would seriously affect their economic growth. It called upon their governments (and those of the developed world) to quickly remedy the worsening situation.

> "The economic and social benefits an efficient telecommunications system confers on a community or a nation can be clearly perceived. The system can also be used as a channel for education, for disseminating information, encouraging self-reliance, strengthening the social fabric and sense of national identity, and contributing to political stability"[1]

The Rich Get Richer And The Poor...Well, They Just Get Poorer:

As the Maitland Commission report is almost nine years old, it is worth examining how well the international telecommunications community, have responded to the ITU's impassioned pleas.

At first glance, I would have to say "Not so well". A large information gap has opened up between telecommunications-affluent countries and Our less advanced neighbors. In affluent countries, information technology has been the main engine of economic growth in the latter half of this century where the use of electronic links for financial and commercial purposes now provides the infrastructure for what is fast becoming a global economy. According to Tadahiro Sekimoto, president of NEC Corporation, "It is now certain that the economic structure of the next age of human society will have the information technology industry at it's center".

Tokyo, for example, has more telephones than the whole of the African continent. Australia, Japan and New Zealand, with just 5% of the Asian population, have 57% of the telephone lines in Asia[2]. In fact, two thirds of mankind still remain outside the reach of a telephone. The Maitland report found that half of the world's population live in countries with fewer than 10 million telephone lines (strategically placed in the larger cities) and two thirds of the world's population have no access to telephones. This does not bode well for the closing of the information gap.

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[1] Report of the Independent Commission for World-wide Telecommunications Development (Maitland Commission), The Missing Link, ITU, December 1984

[2] A. Djiwatampu. Transnational Data and Communications Report. August 1993

Advanced nations have long benefited from this often uneven platform. I am indebted to William Ambrose for the following, enlightening story:

> Most of the 6,000 branches of the State Bank of India, India's largest bank, do not have a single computer. Banking transactions are recorded manually in ledger books, with a daily book drawn up at closing. Management reports are also prepared manually and passed up several layers of bureaucracy. Account balances are not on-line and the closest thing to an electronic funds transfer within India is a cable remittance, and this requires manual verification of telex codes. The simplest banking transaction can take several days to complete and may involve literally dozens of people. A check can take ten days to clear.
>
> Meantime, some of the most sophisticated software applications for electronic funds transfer are being developed in software labs in the southern city of Bangalore that are connected by high-speed international data links to US electronic companies. The software developed in Bangalore allows consumers in the US to drive into a gas station, insert a credit card into a slot on the pump, fill their tanks, all without an attendant in sight[3].

It is an obvious story of the rich getting richer and the poor, well they just keep getting poorer.

How Can Developing Countries Benefit From All This?

The availability of newer technologies and the desperate need for modern communications systems are both leading toward deregulation of at least some aspects of telecommunications in many highly regulated countries. Developing nations have a unique opportunity here to leapfrog more traditional communications systems, learning through our experience.

Because developing countries do not possess the same extent of advanced equipment and infrastructure as, for example, we in the States do, this does not mean they are naive in their technical expectations. On the contrary, their needs range from basic telephony to state-of-the-art. These include cellular, synchronized fiber optic transmission systems and VSAT satellite networks. As an example, cellular phone service uptake is growing 50% a year in developing countries [4]. Corporate networks and International Value Added network service platforms are providing new types of unregulated data communications in the developing world.

VSAT satellite networks, many of which are privately run, are growing rapidly, most notably in Brazil, Mexico, Poland and China. Meanwhile basic switched voice networks are expanding at more than 10% a year in China, Indonesia, Iran and Pakistan and slightly less rapidly in several other developing countries[5]. Several of these countries are experimenting with alternative methods of combining public and private resources to provide expanded telecommunications facilities.

> "Satellites have put millions of Chinese in touch with developments outside, and no matter how hard the government might strive to contain the information virus, the authorities are fighting a losing battle"[6]

Leapfrogging: Who Can Afford It?

For a variety of reasons, not all countries can readily afford to create the infrastructure necessary to absorb the wonders of the technology revolution. Computers are scarce and expensive in Asia, Latin America and Africa and telecommunications costs can be prohibitive.

There is another element of this puzzle which is exclusive to most developing countries. Increased technology usually means less reliance on manpower. In countries where manpower is cheap and unions strongly resist automation, the country's technological advancement invariably lags behind. Poor education systems greatly limit the number of professional workers capable of understanding and operating complex telecommunications systems. Technological progress can be a deadly, two-sided political sword.

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[3] Leapfrogging economic development, World Times, February 1993

[4] Telecommunications Development Report, Volume 8, Number 1, Pyramid Research, Inc. January 1993

[5] Communications and Information in the Post Cold War Era: Forces and Trends, Harvard CIPR, May 1993

[6] Tony Walker, "Hats Off to the Revolution", Financial Times, March 1993

What Are The "Hot Technologies" That Are Influencing World Communications ?

Technologies are converging at a rapid rate. An example is the confluence of fiber optic technologies, digital compression techniques and digital storage technologies. And not just the technologies are meeting but also the industries they support. We can think in terms of a three tiered architecture consisting of an underlying network and switching layer, an information management and operating system layer and finally a service applications layer. At each layer, traditionally independent and discrete industries are merging, some might almost say, crashing into each other. It is an exciting and challenging time for all of us in industries from telecommunications providers to cable T.V. providers to computer applications developers.

A comprehensive technological platform, capable of support demanding new services will be very complex. It will have to address many inter-related issues such as call management, service and information management, loop access, video and multimedia servers, OSS for these new platforms and CPE, to name just a few.

The role of one particular technology will have an inordinate effect on the near term future of communications. Asynchronous Transfer Mode (ATM) technology is ultimately going to displace all other switching technologies. Its evolution will be paced by a number of trends in the industry, primarily distributed computing, client/server models and by the increasing demand for multimedia and imaging applications. ATM stands for Asynchronous Transfer Mode. It is basically a format for packaging and transmitting computerized data and images over telephone lines at more than 45,000 the speed of current telephone lines. Besides its speed, the main appeal of ATM is that it offers a single standardized way to transmit all kinds of information, from high quality movies to medical images to electronic books.

ATM is the first major instance of the computer and communications industry concurrence on a communications platform and this means that ATM will be at the core of future data telecommunications networks and future customer's private networks.

The United States Government is also heavily involved. President Clinton's "Electronic Superhighway" will do for data what the interstate highways did for cars. In essence it will change how people conceive of and conduct their business.

A Word About ATM:

The "Asynchronous" transfer in ATM means that information is assigned to telephone lines on demand, allowing numerous computer conversations to occur simultaneously. This approach to transmitting information, known generically as packet switching, has been around for years. What makes ATM special is that it can support voice, video, high-definition T.V., high quality images etc.

The simplicity of the ATM protocol means that it can be deployed in a faster manner than traditional packet switching protocols. Because of the inherent simplicity of the ATM protocol, ATM is being integrated right into hardware. In other words, manufacturers are building ATM-based integrated circuit chips. In previous packet switching, the protocol was always handled in the software. By incorporating it into the hardware, it is reasonable to expect an increase in performance of three orders of magnitude. It is also reasonable to expect that ATM will be the next major platform adopted by any developing countries attempting to "catch up" with their more technologically advanced neighbors.

A large number of companies are currently producing integrated circuit chips which will support a wide range of products available throughout 1993. These chips will permit massive parallel and cost effective architectures. These parallel architectures will, in turn, permit high capacity switching systems that will support 2,5000,000 voice calls or 200,000 video conferences or 30,000 broadcast video channels or 4,000 HDTV channels simultaneously.

Given that our world is being shrunk into a "global village", in real terms ATM means that we could move the work to the people, instead of moving the people to the work.

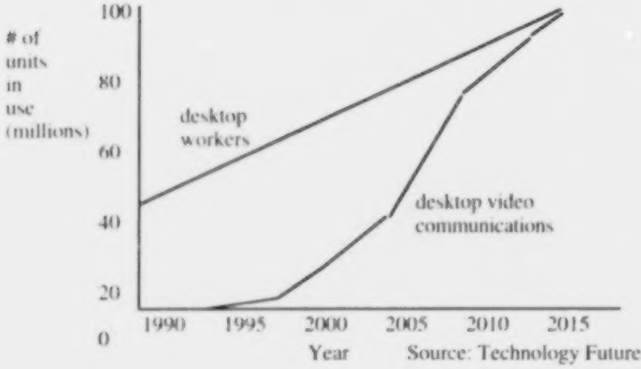
Multimedia and Middleware:

Certain terms abound in ATM discussions. Two major term are Multimedia and Middleware. Firstly let me define **Multimedia.**

Quire simply, multimedia is a combination of the following:
  Multiple users
  Multiple processes/processors
  Conversational computing environment
  Utilizing voice/data/text/images/video
  Fully integrated network environment
  Transparent interface
  Allowing near instantaneous response

Multimedia is no longer just a "buzz" word. It's here and it's real. ATM network deployment is being hastened by the pull created by business operations-centric applications that use multimedia capabilities in the day-to-day business environment. For example, Caterpillar is introducing an Electronic Performance Support System that provides learning modules and reference information to workers on the factory floor. Multimedia capabilities are being embedded in the mainstream operation of this and other businesses. By 1996 almost one million desktop video units will be in use.

MARKET ADOPTION OF DESKTOP VIDEO COMMUNICATIONS



Source: Technology Futures Inc.

Multimedia will change forever the information industry because it presents information in a format that is closer to the way we think, thereby echoing the fundamental way we absorb information from the world around us. Multimedia will have the same staggering effect on our industry in the 1990s as the emergence of PCs had in the 1980s. A market study by INTECO (news release April 1990) predicts sales of hardware to run multimedia will grow to $15 billion in 1994. Sales of multimedia software will grow to $5.5 billion, giving a total US. domestic market of over $20 billion by 1994.

Middleware is also an essential component of network-based communications systems. Middleware permits the real time sharing of images, conversation, messages and transactions in support of collaborative work among geographically dispersed locations.

If you think of communications in terms of the human body: Fiber would be the arteries and veins. Data would be the blood. ATM would be the heart, pumping blood through the system. And Middleware would be the brain, managing the operation to ensure that all necessary requirements were satisfied.

Applying the NYNEX Strategy in a Worldwide Context:

NYNEX Science & Technology has been involved in several trial activities in the area of broadband services over the past few years. Our strategy, which holds for international as well as national business is to concentrate on customer needs for an image intensive, time sensitive or dispersed enterprise business. While the applications and the customer needs are diverse, the NYNEX approach is quite simple. We study how our customers do business to discover that:

1. Human work is accomplished by communities of interest

2. These communities are established and sustained by conversations which take place in the context of work sessions.

3. The conversations that people have with each other form a network of relationships that make work possible.

With a long history and tradition of providing public networked service, NYNEX is committed to applying these principles in a technology that emulates a conversational work environment. High speed visual communications over ATM will support the fundamental principles of communication - expression, articulation, response, exchange, dialogue even improvisation.

The Changing Face of Telecommunications Around The World - Video and Data Will Subsume Voice-

The convergence of video, multimedia and ATM technology are blurring the old distinctions between "voice" and "data", between "Information provider" and "Information supplier", between the cable industry, the traditional Telephone Companies, data providers and the computer world.

As the complexity and quantity of data increases in the next decade, so will the numbers of subscribers, as the world is increasingly focused in terms of the "global communications village". This trend alone makes the role of the public switched network even more critical as an access mechanism and a cost-effective information provider.

In our design of tomorrow's networks, one axiom holds true: video and data will subsume voice. Even today, telecommunications in developing countries is still measured in terms of telephones per head. If developing countries are to prosper in this new computer age, they must plan video and data communications networks, not just voice networks. Voice networks might help them today, but there is no question that, without a comprehensive and intelligently planned communications infrastructure, less developed countries will never fully compete with their more technologically advanced neighbours.

It is in the best interests of developed countries to assist less developed countries in an attempt to introduce a more equal distribution of communications systems worldwide. Governments of developed nations view information and communications as critical elements of the infrastructure. Today governments of developing countries are convinced of the same. To put it another way, Dr. Schwartz-Schilling, Germany's former minister of post and telecommunications, "The lack of an efficient telecommunications infrastructure was certainly one of the reasons for the economic decline of Eastern Europe in the last 45 years".

By assisting in the technological advancement of developing countries, by teaching them our hard-earned lessons, by actively promoting the expansion of robust data communications networks that can also carry voice, we are ensuring a larger, more robust and ultimately more profitable marketplace for us all.

"Foreign Direct Investment and the Pacific Rim's Trade of Telecommunications Equipment; A Chinese Case Study"

William J. Bien, U.S. Department of Commerce

January 17, 1994

1. ABSTRACT

As Pacific Rim telecommunication markets grow, Asian governments are encouraging, and sometimes requiring, exporters to directly invest in Asian manufacturing enterprises. This paper examines the effects of this trend on telecommunication equipment exports to China.

2.0 INTRODUCTION -- PACIFIC RIM TELECOMMUNICATIONS

The Pacific Rim is home to the fastest growing economies in the world. Between 1985 - 1990, Pacific Rim economies expanded 7 - 9 percent annually. In comparison, the world economy only grew about 3 percent during the same period. The Pacific Rim's expansion continued during the global recession of 1990 to 1992, and Pacific Rim countries collectively grew 4-6 percent during this difficult time. Some experts believe this growing regional trade is driven by expanding consumerism and national modernization programs.

The Pacific Rim's telecommunications industry reflects the region's growth pattern, as shown in figure 1.

Figure 1: Pacific Rim Telecom Networks

Main phone lines (millions)	1988	1990	1992*	1995*
Australia	7.0	7.8	8.3	9.1
China	4.8	6.9	12.5	42.5
Hongkong	2.2	2.5	2.8	3.5
Indonesia	0.8	1.1	1.5	2.2
Japan	50.3	54.5	58.4	63.2
Korea (Rep. of)	10.3	13.3	16.1	21.1
Malaysia	1.2	1.6	2.1	3.3
New Zealand	1.4	1.5	1.5	1.6
Philippines	0.6	0.6	0.7	0.8
Singapore	0.9	1.0	1.2	1.3
Thailand	1.0	1.3	1.8	3.0
Taiwan	6.1	7.4	8.7	11.1
Pacific Rim Total	86.6	99.5	115.6	162.7

* Estimated on the basis of national reports

Sources: ITU, APEC

Figure 1 estimates each Pacific Rim countries' main telephone lines in operation in 1990, 1992, and 1995. In 1992, Japan had the most telephone lines, but China, Australia, and Taiwan also had a significant number of lines. Figure 1 also suggests the explosive growth that awaits the region -- the Pacific Rim's telephone lines are expected to increase from 115 million in 1992 to over 160 million in 1995.

Overall, the Pacific Rim's telephone lines will annually increase approximately 15-20 percent during the 1992-1995 period. Most of this growth will occur in China. Indeed, China's annual growth rate is the highest at approximately 80 percent; Thailand, Indonesia, and Malaysia will also exhibit fantastic growth rates, ranging from 15 to 25 percent. Pacific Rim line growth will also stimulate significant growth in the region's equipment markets, as shown in figure 2.

Figure 2: Pacific Rim Telecom Equipment Markets
Estimated 1992 and 1995 values in million $US

Country	1992	1995
Japan	$16,223	$17,727
Malaysia	$2,453	$3,730
Singapore	$2,479	$3,037
Australia	$2,600	$3,461
Korea	$2,577	$3,919
Hong Kong	$1,593	$2,423
China	$2,000	$3,955
Taiwan	$1,500	$2,164
Indonesia	$750	$1,141
Thailand	$700	$932
Philippines	$681	$1,676
New Zealand	$402	$427
Total	$33,958	$44,591

Source: U.S. & Foreign Commercial Service

Figure 2 compares the 1992 Pacific Rim telecommunications equipment to the projected 1995 market.[1] The 1992 market is valued at $35 billion, while the 1995 market is expected to exceed $47 billion. Although Japan will remain the largest equipment market in the region, growth in other national markets will be the catalyst for this expansion. These markets include China, Malaysia, Korea, and Indonesia. The Pacific Rim's market growth will likely stimulate greater demand for sales opportunities throughout the region.

These opportunities, however, may not necessarily correspond to export sales for manufacturers in North America, Japan, and Europe. Although Pacific Rim markets will offer substantial export opportunities for producers in these three regions, many of these opportunities will only be available to exporters that directly invest in the Pacific Rim telecommunication industries.

Fortunately, a review of recent market activity in China shows that multinational manufacturers are cognizant of this trend and have already invested in China. The effects of foreign direct investment requirements on exports to China, however, have remained largely unexamined. This is unfortunate because China will become Asia's fastest growing market for telecommunications equipment during this decade, as suggested by the telecommunication and line growth figures already discussed.

The purpose of this paper is to examine the effects of foreign direct investments on telecommunication exports to China. This examination consists of three parts: an overview of China's telecommunications industry, a review of foreign direct investment (FDI) in the Chinese telecommunications equipment industry, and an analysis of exports to China.

3.0 THE CHINESE TELECOMMUNICATIONS INDUSTRY'S EXPANSION

During the 1980s, the Chinese telecommunications industry grew quickly. China's overall network switching capacity, as measured by the number of access lines, increased 11 percent during the past decade. In 1992, the Chinese Ministry of Posts and Telecommunications (MPT), China's primary service providers, installed nearly 2.8 million lines. In comparison, China installed 1.9 million lines in 1990 and 1.1 million lines in 1988.

Capital investment in China's network increased at a 25 percent rate each year during the past decade. Aggressive capital investment will continue as the MPT and provincial carriers strive to expanded China's network capacity to 31 million lines by 1995 and to 100 million lines by 2000. To achieve these goals, analysts expect that the Chinese telecommunications industry will invest $7 to $10 billion in new plant and systems upgrades between 1991 and 1995. This is substantially higher than the $4 billion that China invested between 1985 and 1990.

Specific goals for this increased investment include linking all of China's major cities to a new 33,000 km fiber-optic trunk network, and upgrading most urban networks so they have automatic switched services and domestic direct-dial capability by 1995. Provincial carriers may invest additional funds to meet the demands of their growing economies. For example, Jiangsu and Guangdong, two growing coastal provinces, are likely to each add over a million lines annually between 1995 and 1999.

These goals have attracted the interests of foreign telecommunication equipment manufacturers, who have become active participants in China's market. These manufacturers have participated in China using three different strategies: licensing technology to Chinese companies, exporting to China, and directly investing in Chinese telecommunications manufacturers. Although most manufacturers licensed technology during the 1980s, the MPT is reportedly discouraging future licensing agreements. Thus, foreign manufacturers who wish to participate in China will likely have to either directly invest in a Chinese enterprise and/or export products to China.

3.1 FOREIGN DIRECT INVESTMENT IN CHINA'S TELECOMMUNICATIONS INDUSTRY

Foreign direct investment (FDI) in China's telecommunications equipment industry is not a new phenomena. In fact, foreign telecommunication equipment manufacturers have directly invested in China since 1983. Figure 3 shows the incidence of foreign direct investment in China's telecommunications industry between 1983 and 1992.[2]

Figure 3: Telecom FDI projects in China
By year and region of origin

YEAR	NA	EC	Japan	Other	TOTAL
1983	0	0	0	1	1
1984	1	1	3	0	5
1985	2	5	1	0	8
1986	5	2	2	0	9
1987	2	4	2	0	8
1988	1	3	1	0	5
1989	0	1	1	1	3
1990	1	0	0	0	1
1991	0	1	2	1	4
1992	3	1	2	3	9
1993	4	1	1	3	9
Totals:	19	19	15	9	62

Key: NA= North America, EC = European Community
Sources: Corporate Reports, Enterprise Development International, AT&T , Network Dynamics

Most of this investment comes from three sources: the European Community, North America, and Japan.[3] Telecom FDI in China appears to have flowed fairly evenly from these three regions during this time frame. European companies and North American companies have both invested in nineteen Chinese telecom equipment enterprises, and Japanese companies have invested in fifteen enterprises. In total, manufacturers worldwide have invested in sixty two Chinese telecommunication equipment manufacturing enterprises since 1983.[4]

These FDI enterprises focus on several product groups. Most enterprises produce fiber optic cables and related equipment (15 enterprises) or switches (14 enterprises). However, a substantial number of enterprises produce radio communications equipment; seven enterprises produce microwave equipment and seven enterprises produce cellular communications and paging equipment. Three enterprises also produce integrated circuits for switch manufacturing.[5]

3.2 FDI AND EXPORTS OF TELECOMMUNICATIONS EQUIPMENT TO CHINA

Figure 4 compares North American, Japanese, and European Community exports of telecommunications equipments to China.[6]

Figure 4: Telecom equipment exports to China values, millions of U.S. dollars

YEA	NA	EC	Japan	TOTAL
1989	83	112	125	320
1990	150	148	86	384
1991	183	192	102	477
1992	432	277	299	1008

Key: NA = North America, EC = European Community
Sources: United States, Canadian, European Community, and Japanese trade statistic

These exports have collectively increased at a 46 percent annual growth rate from about $320 million in 1989 to slightly more than $1 billion in 1992. The fastest growing exports are North American exports, which grew at an annual rate nearly double the Japanese and European rates.

The product distribution of telecommunication equipment exports, as shown in figure 5, is similar to the product distribution of FDI enterprises in China. Both FDI and equipment exports are concentrated in switches and radio communications equipment, including cellular phones. However, telecommunication exports are less concentrated in fiber optic cables and related equipment than are FDI enterprises.[7]

Figure 5: Distribution of telecom exports to China

	1989	1990	1991	1992
Switches	26%	30%	30%	30%
Wireline parts	28%	24%	31%	24%
Radio comm. equipment	2%	12%	14%	12%
Communication satellites	0%	8%	0%	8%
Terminal equipment	3%	6%	7%	6%
Line apparatus	12%	6%	3%	6%
Fiber optics equipment	1%	4%	3%	4%
Radio communication part	4%	3%	3%	3%
Cellular phones	0%	2%	6%	2%

Based on author's calculations

Figure 5 also reveals that parts for wireline and radio communications equipment represented 20 to 30 percent of telecommunication equipment exports to China between 1989 and 1992.

Several factors lead to this consistently high concentration of parts exports to China. One factor is the presence of the FDI enterprises in China. These enterprises have historically imported significant amounts of telecommunication parts for products they sell in the Chinese market. These parts enter China in the form of semi-knock-down or complete-knock-down kits with key modules made in the exporter's home factory. According to industry press reports and consulting studies, these kits are the basis for much of China's current production of telecommunications equipment.[8]

3.3 FDI'S EFFECTS ON TELECOMMUNICATION EXPORTS TO CHINA

Inconsistent data prevents a clear definition of the relationship between telecommunications FDI in China and telecommunication exports to China. However, FDI enterprises do not appear to have significantly affected exports to China. The qualitative data explained above suggests that FDI enterprises actually facilitated Chinese imports of telecommunication parts from foreign manufacturers. Moreover, the rapid growth of exports of complete telecommunication products to China, such as switches, has continued unabated during recent years. Thus, it does not appear that FDI enterprises have significantly adversely affected telecommunications exports to China.

It is unclear, however, whether this pattern of trade will continue because of a new MPT policy. The MPT announced in early 1993 that FDI enterprises must increase the local content of their products to 60-70 percent of the value of their products.[9] The effectiveness of this regulation will only become clear through future examination of FDI enterprises in China and international exports to China.

ACKNOWLEDGEMENTS

1. The author thanks Enterprise Development International, Network Dynamics, and AT&T for their assistance in gathering data for this paper.

2. The author is soley responsible for errors in this paper.

ENDNOTES

1. Based on statistics tabulated by the Department of Commerce's U.S. and Foreign Commercial Service.

2. This table only lists the number of foreign direct investments made annually, and does not examine the contractual value of these investments. Contractual value information is not widely available.

3. Other investors include Scandinavian, Korean, and Hong Kong companies.

4. This total does not include investments forecasted to occur in 1994. If these investments were included, then the total would surpass 70.

5. Integrated circuit investment actually supports FDI in China's central office switch industry. Beijing requires foreign central office manufacturers to invest in integrated circuit enterprises when they invest in central office enterprises.

6. These statistics are based on United States, Canadian, Japanese, and European Community records of telecommunication exports to China. These exports figures were used for estimating Chinese imports because of the unavailability of Chinese import statistics.

7. Trade statistics do not have a specific classification for microwave equipment, so no direct comparison between export statistics and FDI enterprises are possible.

8. "Telecom Races Ahead", Sid Gorham and Achmad Chadran, **The China Business Review**, March-April 1993, p. 19; "Dialing into the China Market", Windy Zou, unpublished manuscript, August 1993.

9. "Telecom Races Ahead", Sid Gorham and Achmad Chadran, **The China Business Review**, March-April 1993, p. 20.

INTERNATIONAL DEREGULATION -
WILL DEVELOPING ECONOMIES SUFFER?

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1. ABSTRACT

Recent years have seen a dramatic change in the approach to the provision of telecommunication services, most notably in developed countries. This paper considers some of the changes as most nations aim toward a deregulated policy. The impact on developing economies is examined as the trend would seem to increase the gap between developed and developing countries although mitigating factors exist.

2. INTRODUCTION

2.1 TELECOMMUNICATIONS PROVISION

The provision of telecommunications facilities varies significantly between countries. Three factors predominate in contributing to the disparity:

- the income per capita
- the population of the country
- the degree of urbanisation.

The relation between income and telephone provision is illustrated in Figure 1. Obviously a wider variety of services can be provided when telephone lines can be measured in millions rather than hundreds. Provision (and use) will also be affected by the population density, being substantially different between cities and rural areas or remote islands. There are also other factors, some inter-related and, for example, a relationship between GNP per capita and urbanisation can be established, as in Figure 2.

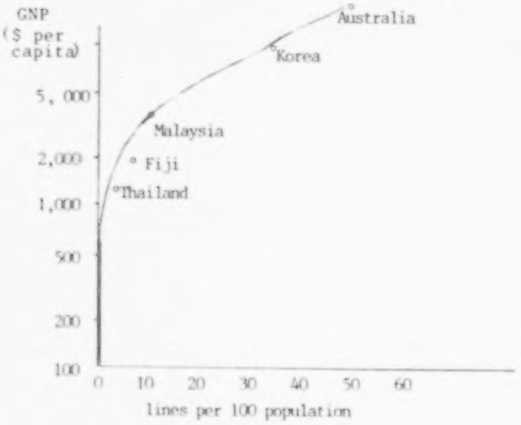

Figure 1 - Telephone lines v income

2.2 DEREGULATION

The concept of deregulation is complex and also subject to varying definitions. The majority of nations are moving in this direction, progressing at different rates and along differing routes.

Governments have some reluctance to permit a totally free telecommunications sector for various and valid reasons such as:

- telecommunications are a key part of modern infrastructure
- government and military are major users
- the sector accounts for around 6% of GDP and 10% of national R&D
- government may need control in disaster scenarios.

In less developed nations these factors are likely to have greater impact and additional factors, such as the political impact of overseas influence in provision, will be important.

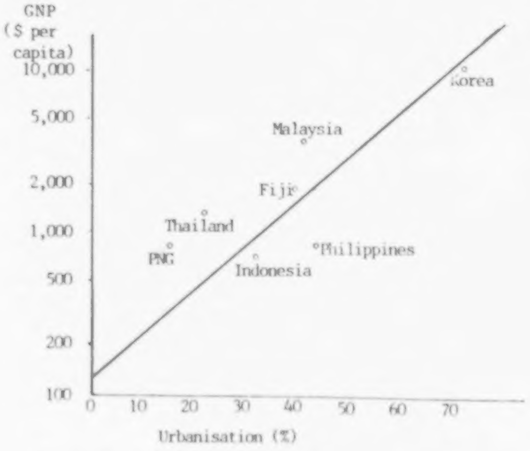

Figure 2 - GNP (per capita) v urbanisation

However it is recognised that enhancement of telecommunications provides a catalyst to economic development, through the business sector. Currently the most efficient method of achieving this enhancement is through fully or partially deregulated provision.

2.3 EQUIPMENT AND SERVICES

The issue of deregulation may be divided into two areas, the provision of equipment (i.e. manufacture, supply and installation) and the provision of services. Supply of equipment to carriers is substantially deregulated with equipment being manufactured in international volumes rather than for specific countries.

Carriers supplying services are still subject to significant, but decreasing, controls. Much of this has the aim of protecting the end user and ensuring that true competition is achieved and maintained.

2.4 BENEFITS TO DEVELOPING COUNTRIES

The increasing degree of standardisation throughout the world has resulted in a reduction of equipment costs with simplified procurement and systems integration.

The pressures for increased operational efficiency, coupled with increasing equipment reliability, means that operation and maintenance procedures can be simplified (albeit with some potential drawbacks). In addition the decreased cost per circuit of long-haul routes can result in economic access to remote areas.

2.5 FINANCING

Realism in the real world indicates that financing a modern telecommunications infrastructure can impose strains on countries with low GDP's. In Canada, Stentor estimates an investment of close to $1.5 billion in the installation of optical fibre across Canada, providing support to a population of 11 million, whilst, in the UK, Mercury (the second carrier, created in the mid 1980's) has invested around $3 billion to establish its network.

The two examples indicate that establishing, or even developing, a national network requires significant investment and, of course, the cost is not a once off payment; provision has to be made to keep the facilities up to current standards as well as matching the developing requirements in the international market.

The financing of network development becomes complex for some countries as they seek to maintain an independent strategy whilst offshore investors, making significant investments, wish to minimise their risk.

Whilst less developed economies may wish to limit the development of more advanced services, they may frequently find themselves "locked-in", not least as software increasingly becomes an integral component of equipments.

The end result is that similar levels of facilities will increasingly exist in both developed and developing countries, resulting in similar costs across the globe. However when the call cost to per capita income is examined it will be seen that a disadvantageous differential is created.

3. WHAT IS DEREGULATION?

3.1 THE ROLE OF THE 'OLD STYLE' PTT'S

It is important that consideration is given to the starting point - the original role of the PTT. Until relatively recently the PTT of each country had a monopoly in the provision of telecommunication services, both with respect to internal and international services. In addition it was the sole provider of all telecommunications equipment and of its installation and maintenance.

In most cases investment and operating costs were separate and the 'business' operated on day to day costs with some notional allowance being made for capital expenditure. The mandate was to satisfy demand and speculative expenditure to anticipate increased demand, except as defined in government infrastructure plans, was discouraged. Management was encouraged to meet the plan and to spend up to their budgets.

Suppliers to the PTT's had to be approved before being able to 'bid' for work and had to meet specific local conditions. 'Value for money' was ensured by audits of spend by the suppliers and development of new equipment carried out on a 'cost plus' formula. Speculative developments were effectively discouraged.

Each country operated its own set of standards, extending down to virtually every component, again suppressing innovation.

3.2 THE OBJECTIVE

The long term objective is that any supplier should be allowed to provide telecommunications services, both national and international, direct or indirect, to the end user. This objective is, of course, difficult to achieve, bearing in mind the requirement that a 'level playing field' is achieved to provide 'fair' opportunities for competition.

Even within a single country it is difficult enough to create a solution that allows the old PTT's to be fairly opened up to competition. At an international level it is even more complex as the major players seek a global dominance, either directly or through strategic alliances. As at national level, the issue is how to ensure that services are distributed fairly and not solely concentrated on the most profitable areas.

3.3 STEP BY STEP

The approach to deregulation has been gradual in most countries. The creation of a separate Telecoms Corporation, initially reporting to the government and then with private shareholding establishes the organisation as a business and provides a framework in which limited competition can be introduced. Whilst most privatisations have taken place relatively smoothly, some difficulties have been experienced, notably when shares have only been open to a limited segment of the market.

This approach does not fit with all cultures and other models need to be developed. One such is that of a government inviting open bids for BTO (Build, Transfer, Operate) networks, thus providing telecommunications infrastructure costs at international market prices whilst still "owning" the system.

3.4 COMPETITION

A key element of the road to deregulation is the introduction of competition. The UK, New Zealand and Australia are examples where a second carrier has been introduced as part of a phased move towards more open competition.

Competition can be introduced as either a choice of long-haul carrier or through alternative suppliers at the access network level. Whilst the former is more common (except for very large users), an option is to offer telephony as an adjunct to broadband services such as cable TV.

Long haul routes can be provided by new 'traditional' carriers (i.e. companies dedicated to telecommunications) or by other organisations (e.g. utilities wishing to diversify).

3.5 COSTS

The impact of competition is to drive prices downwards. However figures to date should be treated with some caution. New technology and management approaches have an equally important part to play and Figure 3 illustrates the call charges for a monopoly supplier moving towards 'defensive' competition (Norwegian Telecom).

4. USER BENEFITS

4.1 A MARKET ECONOMY

The key transformation to the user is that telecommunications provision is now made, in most countries, on a market rather than directed basis. Traditionally PTTs needed to meet certain requirements and no more. If lines were not available in a certain area then the user had no option but to wait for a connection. Similarly, provided minimum service standards were met, then the user had no recourse.

In moving to a market economy all carriers have become more responsive to their customers. This applies to both traditional services and the new "value added" facilities. Indeed the carriers are looking to a broader range of services to balance the revenue decline in traditional services that is the result of competitive pricing.

4.2 FLEXIBILITY OF OPERATION

In the past PTTs enforced certain operational rules to protect their revenue. This meant that flexible use of telecommunications facilities was restricted, not by technical considerations, but by artificial and bureaucratic considerations.

Now users have flexibility but complex options and changing tariffs mean that the user is forced into frequent changes if he is to keep up with the current technology.

4.3 DEVELOPING ECONOMIES

Whilst it is easy to become bemused with the options in the developed countries, it should be remembered that in some countries even access to a telephone instrument is a luxury. However it also provides the means of obtaining medical services and other such facilities. Whilst much effort has gone into the development of complex facilities, work on systems for rural telephony is on a much more limited scale (1). There is still a lack of initiatives in developing not only the technology but in assessing the potential user benefits, not simply in telecommunications terms but in broader social and developmental terms (2).

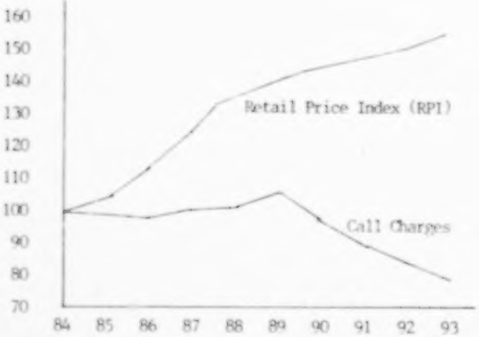

Figure 3 - Ratio between call charges and RPI

5. NETWORK MODERNISATION

5.1 GENERALISED STRUCTURE

Modernisation of a typical national network comprises 5 elements:

- Subscriber (customer premises) equipment
- Local (access) network
- Trunk network
- International gateway(s)
- Management equipment.

5.2 SUBSCRIBER EQUIPMENT

In most developed economies individual subscribers expect a level of sophistication in their telephones (even if only storing frequently used numbers) whilst businesses will normally utilise electronic switching. However in other nations businesses manage with basic connections whilst a village telephone for the rural population is considered as keeping up with the times!

This is not to imply that most developing countries do not have advanced telecommunications in the major cities but, in considering needs, it is important not to extrapolate these facilities to the rest of the country. Whilst modernisation may imply jumping several generations of equipment, it is important that realistic assessment is made of user need and calling rate and that appropriate end user technology is deployed.

5.3 ACCESS NETWORK

The connection of telephones to the local 'exchange', whether this is an actual switch or a node giving access to the wider network, is again an area that needs sensitivity to local conditions. Whilst fibre is increasingly used in developing countries it must be recognised that, for local distribution, it does have drawbacks. Careful examination of the economics, and balancing the requirements of users may result in different solutions to those used in major economies.

5.4 TRUNK NETWORK

It is in the trunk, or national distribution, network that the benefits of standardised equipment offers real benefits. The use of fibre and satellite technology can be fully exploited and the country can be 'rewired' as in the case of Thailand where the use of railway routes supplemented by 'festooned' submarine coastal links, provide a solid foundation on which to build local connections.

5.5 INTERNATIONAL GATEWAY

Provision of international connections to developing countries has become more complex. The emergence of a few dominant players mean that careful assessment and selection of partners is needed if optimum benefits are to be achieved.

5.6 MANAGEMENT EQUIPMENT

A key component of modern equipments is a plethora of management aids. From customer billing to fault finding in the local loop, there is a computer aided solution. Vendors assume computer literacy, air conditioning, and reliable, transient free, power supplies. For rural telephony these assumptions must be reviewed and related to local conditions. Certainly central locations can take advantage of these developments but local support needs careful review.

6. FOCUS FOR THE FUTURE

6.1 APPROPRIATE TECHNOLOGY

Significant effort has gone into developing equipment for the particular needs of the North American and "Western" markets. However the particular needs in developing economies are seldom taken into account, partially because this is not deemed as a 'prime market' and partly because few studies have been undertaken of such needs. As a result 'adapted' equipment is utilised - not an ideal recipe.

6.2 FUNDING

The options for funding a major programme fall into 3 categories, government funding, international funding and commercial funding. Currently the major option is for international funding. There is a strong case for ensuring that the developments are appropriate for national needs, are capable of in-country support and have a forward path for future development.

An alternative approach is to undertake limited development for major businesses on a self financing basis to enable the economy to move forward - one model of 'deregulated thinking'.

6.3 SUSTAINABILITY

This paper has charted progress in the developing economies towards deregulation. Whilst noting the dramatic strides made over the past few years, the only conclusion is that, for the foreseeable future, international telecommunications will be undergoing rapid change. However developing economies are looking for stability if they are to sustain an investment in modernisation.

6.4 WILL DEVELOPING ECONOMIES SUFFER?

The short answer is "probably"! Whilst developing economies benefit from the downward trend in equipment costs, the need for investment at world prices will mean that a significant expansion of the telecommunications infrastructure will have a disproportional impact as a proportion of GDP and/or of national debt. Yet the reality is that the needs for economic expansion may force the issue.

Since "The missing link" was written, almost a decade ago, little progress is evident on a suitable forum to direct work towards the needs of developing countries. The need to avoid a growing gap through forging new links has never been greater - the question that still remains is how to initiate meaningful activity toward this goal.

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Telecommunication Network Development in China
- Growth and Challenges -
Implications for Structural Reform

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1. ABSTRACT

China is well poised to become one of the fastest growing and most dynamic world economies in the next century. The profound, rapid and far-reaching social and economic transformation in China over the last decade has seen a staggering and unprecedented development of China's telecommunications. However, a further and sustainable growth of China's telecommunications will require major improvements in operating efficiency and full exploitation of the benefits of new technologies. To achieve its ambitious expansion plan by the year 2000, structural reform will be necessary. This paper examines some of the background issues necessary to develop an effective program of structural reform.

2. INTRODUCTION

Ten years ago, two important ingredients of the Maitland Report *Missing Link* were to call for developing countries to give a higher priority to investment in telecommunications, and the improvement of the operating efficiency. (1)

In response to the above recommendations, China has regarded telecommunications as a strategic sector in its economic development and the prerequisite for opening to the outside world. Telecommunications has therefore enjoyed a development priority and an array of favorable policies and concessions on taxation, government loans and the flexible use of foreign currencies. (2) The result is impressive and unprecedented. From 1982 to 1992, the number of telephone main lines increased from 2.3 to 11.5 million, a compound annual growth rate (CAGR) of 17.2%. China's international outgoing traffic jumped from 10 million minutes in 1982 to 440 million minutes in 1991, representing a CAGR of 52.3%, the second highest growth rate and well above the average of 26% in the rapidly growing Asia Pacific region.

Despite the impressive growth, the capabilities of the network, however, continue to lag far behind the pent-up demand. Teledensity is still under 1.5%; waiting lists for telephone lines continue to grow dramatically; waiting time for telephone lines continues to lengthen; most long distance telephone circuits are seriously overloaded resulting in a completion rate for incoming and outgoing long distance traffic ranging from just 10% to 15%. (3) Performance indicators in terms of percentage of capacity use of main lines relative to total capacity of local exchanges, main lines per employee, revenue per employee and revenue per main lines rank as one of the lowest in the region.

As demand for telecommunications services has outgrown supply, compounding current problems and creating new ones, the Ministry of Posts and Telecommunications (MPT), China's public network operator, is now under increasing pressure to satisfy pent-up demand, improve operational efficiency, introduce competition and start institutional reform.

3. TELECOMMUNICATIONS "BOOM" IN CHINA

China's telecommunications growth for the past three years can be described as a "boom". Table 1 shows the basic indicators of China's telecoms growth during the period of 1990-1992, in which mainlines increased by 29.6%, telephone sets 20.6% and the capacity of local exchanges 24.9%. According to the latest figures recently released by the MPT Vice-minister and other officials, by the end of October 1993, the number of telephone sets has reached 23.72 million and total capacity of public switching exchanges 25.1 million. (4)

Table 2 shows the MPT's estimates that by the end of 1993 mainlines will increase to 17.5 million, a growth of 52% over 1992, and teledensity 1.47%; telephone sets 25 million, 32.3% over 1992; exchange capacity 28 million lines, 46.2%; paging subscribers 55 million, 148% increase over 1992; mobile phone subscribers 620,000, 250% up over 1992, and telecoms revenue US$6.33 billion, 63% growth over 1992. (5) Several factors attribute to this phenomenal growth.

3.1 Open Door Policy and Rapid Economic Growth

China's shift from a political and ideological agenda to a focus on economic reform and its subsequent adoption of an open door policy since 1978 have been major driving forces that have transformed and reshaped China's economy and telecommunications. The development of telecoms in a country is often said to correspond with the economic development of that country. According to the United Nations' survey in 1992, China's annual growth of real GDP per capita was 3.9% (1972-1981) and 7.5% (1982-1991), the highest growth rate in the world. Since 1979, China has achieved average annual GDP growth rate of 9% while telecom output 17%.

3.2 Telecommunications – Economic Development Priority

Recognised as one of the cornerstone of economic progress, telecommunications in China has been given a top development priority. During 1981-1990, total investment on telecommunications amounted to only US$3.4 billion (6) while the total investment in 1993 alone is estimated by the MPT to jump to US$5.2 billion, 53% more than the total amount spent during the 1981-1990 period. In 1984, total telecommunications investment accounted for only a tiny proportion of 0.31% (7) of total national fixed asset investment, but it increased to 1.22% in 1991, 1.71% in 1992 and 2.68% in 1993.

Apart from pouring capital into the telecommunications sector, central and local governments have also made flexible and favourable policy changes and concessions to the industry, such as the utilisation of foreign capital. For instance, foreign financing accounted for US$260 million, about 16% of total foreign investments in 1991, and increased in absolute terms to US$271 million in 1992. Other financing totalling $490 million from seven countries has been approved for the importation of switching and transmission systems.

(8) To date there have been about 36 joint ventures involving foreign companies in China. They are worth about $US500 million in investments in telecommunications equipment alone. Foreign capital worth $US1 billion poured into China's telecommunications in the first half of 1993 and MPT expects to receive at least $US1.3 billion from foreign investments in the full year. (9)

3.3 Increasing Integration Into World Economy

China used to rate low on the degree of external economic dependence as measured by the ratio of foreign trade to GDP. But thanks to its continuing open door policy and its increased foreign trade, China has become an integral part of the world economy. Over the past decade, the average annual growth rate of China's foreign trade has been recorded at 13%. In 1978, the degree of foreign trade dependence was 9%, but in 1992 it jumped to 39.8%. The ongoing policy of opening China to the outside world has greatly increased the exchange of information in the political, economic, cultural and technical arena, which, in turn, has created an increasing demand for telecommunications services. The more than 50% CAGR of China's international traffic since 1982 has confirmed this trend.

Table 1

China's Telecommunications Indicators

	1990	1991	1992	CAGR 90-92
Population (Billion)	1.14	1.15	1.17	1.3%
GDP (US$ Billion)	301.7	300.9	418.0	17.7%
GDP per capita (US$)	264.0	260.0	357.0	16.3%
Main (Access) Lines (Million)	6.85	8.45	11.5	29.6%
Main Lines/100 population	0.6	0.73	0.98	27.8%
Telephone Sets (Million)	13.0	14.8	18.9	20.6%
Telephone Sets/100 pop	1.1	1.29	1.61	21.0%
Telecom Revenue (US$B)	2.05	2.67	3.88	37.6%
Revenue as % of GDP	0.55	0.89	0.93	30.0%
Investment (US$B)	1.20	1.62	2.55	45.8%
Investment as % of Rev	59.0	60.6	65.7	5.5%
Automactic Trunk Switching Capacity (M)	0.29	0.48	0.52	33.9%
Long Distance Circuits (M)	0.11	0.15	0.23	44.6%
% of Main Lines Connected to Digital Exchanges		38.0	51.1	34.5%
% of Switching Capacity Used	57.1	57.0	59.9	2.4%
Local Switching Capacity (M)	12.3	14.9	19.2	24.9%
Telecoms Employees ('000)		531.3	559.1	5.2%
Telex Subscribers ('000)		14.0	14.0	0%
Fax Stations ('000)		57.9	89.0	53.7%
Mobile Phone Subs. (M)	0.018	0.048	0.187	222.3%
Paging Subscribers (M)	0.44	0.87	2.22	124.6%

Source (1) *Asia-Pacific Telecommunication Indicators*, ITU, May 1993

(2) *MPT Annual Reports 1991, 1992*

(3) *PTT Enterprise Management*, Monthly Magazine, March, May, Sept. 1993

(4) *China's Telecommunications Development & Policy*, Liu Cai, Director General, Policy & Regulation, MPT, P.R. China, China Telecom & Information Industry Forum, 9 November 1993, Beijing

(5) Special Issue: *Telecommunications in China*, IEEE Communications Magazine, July 1993

Table 2

Telecommunications Network Expansion in China
(1993 -- 2000)
Estimation, Planning & Forecast

	1993 (Est.)	1995 (Plan.)	2000 (Plan.)
Main Lines (M)	17.5	30.0	75.0
Main Lines/100 pop.	1.47	2.46	5.77
Telephone Sets (M)	25.3	39.0	93.0
Phone Sets/100 pop.	2.14	3.18	7.15
Local Switch Lines (M) -- City -- Rural	28.0 21.0 7.0	50.0 38.0 12.0	112.0 85.0 27.0
PBX Lines (M)	11.0	13.0	25.0
Toll Circuit (M)	0.4	0.83	1.95
Toll Automatic Switch Capacity (M)	0.86	1.86	5.64
Mobile Phones (M)***	0.62	1.6-3	5-8
Paging Subscribers (M)**	5.5	12.1	28.6
Capital Requirement (B)*	5.2	10.6 (94-95)	38 (96-2000)

Note *** 1995 figure is forecast based on the 1993 increase rate of 250% over 1992.

** 1995 and 2000 figures are forecast based on the 1993 increase rate of 148% over 1992.

* 1995 and 2000 investment required is forecast based on US$850 per main line added (investment divided by the number of main lines added in 1993). The previous investment of per main line added in last three years (89-91) was US$1,041.2 according to ITU. This might suggest the decline of switching and transmission equipment cost and the MPT continues to enjoy free land from local governments for its network expansion.

Source *China's Telecommunication Development & Policy*, Liu Cai, Director General, Policy & Regulation, MPT, P.R. China, China Telecom & Information Industry Forum, 9 November 1993, Beijing

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3.4 Rapid Adoption and Deployment of New Technologies

As a developing country with a very poor telecom infrastructure to start with, China has proved that its industry could leapfrog via adopting the latest technogies available in the world market. Traditionally and historically, China has been always preoccupied and obsessed with science and technologies. In recognition of a need to provide the most efficient modern communication, China made far-reaching decisions in the mid 80s to expand its underdeveloped telecom networks through importing digital switching and optical fibre technologies. Between 1982 and 1991 about 5.6 million digital lines were imported from several world class digital switching manufacturers. (10)

In Early 1993 China has scrapped its import restriction in digital switching equipment. As a result, the telecom network is moving from analogue into digital technology. Now, around 81% (51.1% in 1992) of main lines are connected to digital exchanges.

4. SOME EFFICIENCY INDICATORS

By vertical and historical comparison, China is proud of the enormous progress and improvement of its telecom infrastructure, evidenced by those impressive figures. But by horizontal and regional comparison, China's telecom industry still ranks one of the lowest in the world. China's telecommunications growth seems investment led rather than efficiency led. Its operational and organisational deficiency has been exposed by the compounding of old and new problems and may be a major stumbling block to its sustainable and healthy growth. As pointed out in the Maitland Report, "many problems over availability and quality of service in developing countries are symptoms of inadequacies in organisation and management, rather than shortage of investment finance".

Despite the telecom boom and rapid digitisation, the capabilities of the China's network seems unable to cope with explosive growth in demand. Teledensity is only 1.47%; waiting lists for telephone lines continue to grow, now approaching one million; waiting time for telephone lines continues to lengthen, currently about ten months. Most long distance telephone circuits are seriously overloaded, and therefore, completion rates for incoming and outgoing long distance traffic ranges from just 10% to 15% in most part of the country. Network capacity is now only 63% used, ranking the lowest among the regional countries. (See Table 3)

ITU has listed three preconditions and targets for rapid expansion of the telecommunications network in the Asia-Pacific region: investment as 40% of telecoms revenue, US$750 revenue per line, and telecoms revenue as 1.5% of GDP. China has met the first precondition but not the other two. China's telecoms investment accounted for 61% of its telecoms revenue over the period of 1988-1991 and 65.7% in 1992 (83% in 1993), well above the regional target. But its revenue per line was only US$348 in 1992 (US$360 in 1993), far less than regional average of US$709 per line, not to mention recommended US$750, the level of which has been already achieved in many regional developing countries such as the Philippines, Sri Lanka and Thailand. China's telecommunications revenue was only 0.96% of its GDP in 1992, also below lower income economies like Fiji, Indonesia, Pakistan, Philippines, Sri Lanka and Thailand. This may indicate the low degree of maturity of China's network development and a great potential for MPT to improve services and increase usages.

Table 3

Mainlines In Service Relative to Total Capacity of Local Exchanges Selected Asia-Pacific Countries (1991)

Countries	Mainlines Per 100 Population	Number of Mainlines in Use (Million)	Total Capacity of Local Exchanges (Million)	% of Mainlines in Use to Total Each. Capacity
Bangladesh	0.21	2.5	2.5	100
Pakistan	0.97	1.1	1.4	96
Hong Kong	45.92	2.6	2.8	93
Vietnam	0.15	0.1	0.11	91
Phillipines	1.03	0.6	0.7	89
India	0.68	5.8	6.8	86
Australia	46.41	8.0	9.5	85
Iran	4.26	2.5	2.9	85
South Korea	33.68	14.6	17.5	83
Thailand	2.73	1.6	1.9	83
Indonesia	0.68	1.3	1.6	82
Japan	45.39	56.3	70.0	80
Sri Lanka	0.73	0.13	0.16	79
Malaysia	9.91	1.8	2.7	67
China (91)	0.73	8.5	14.9	57
(92)	0.98	11.5	19.5	58
(93)*	1.47	17.5	28.0	63

Note(*): 1993 figure is estimated on the basis of actual number of January to September of 1993, and sourced from China's Telecommunications Development & Policy, Liu Cai, Director General, Policy & Regulation, MPT, P.R. China, China Telecom & Information Industry Forum, Nov. 9, 1993, Beijing

Source: Adapted from Asia-Pacific Telecommunication Indicators, ITU, May 1993

Like many developing countries, posts and telecoms in China are not separated. As a result, the MPT usually mixes telecommunications with posts in its financial data. According to the MPT's Annual Report 1992, in 1992, MPT's total investment was US$2.82 billion (11), its total fixed assets value in the book was US$8.8 billion, the pre-tax earnings was US$1.58 billion, so the nominal internal rates of return (IRR) was 17.9%. But if taking into account the estimated inflation rate of 16% in 1992, the real IRR was just 2%. This probably explains in part why its US$348 revenue per line was the second lowest in the region, about 50% lower than the regional average of US$709.

Another indicator is the MPT's charges of international calls in comparison with its overseas identical counterparts. Table 4 demonstrates that prices for China's international telephone call is the highest compared to the regional countries. On average, they are 48% more expansive than three regional OECD countries, 140% higher than upper income countries, and even 47% more than the same income economies. This is also a clear indication of why China enjoys the international traffic imbalance in its favour. Furthermore, the higher price is compounded by a very high disproportional charges relative to the income level of China's subscribers. The average cost of around US$9 per three minutes for an international call in China accounts for 2.5% of US$357 GDP per capita in 1992. Higher price results in very lower use of international telephone service, just 0.4 minute per inhabitants compared with 13 minutes in the regional OECD countries, 25 minutes in upper income countries and 1 minute in the lower income countries. (12) International telephone demand is usually price elastic, the lower price the higher usages, and the more revenue. The experience in tariff reduction in international traffic in those countries subject to carrier competition seems to conform to this argument. There is no reason to suggest otherwise for developing countries like China as its demands are limitless.

Table 5 shows that China's local telephone access charge is the most expensive in the world. In 1992 the average access charge for a telephone line from the list of nine typical cities was US$921 for business subscribers compared to the average regional lower income countries US$151 (regional average US$148) and US$668 for residential subscribers compared to the average regional lower income countries US$199 (regional average US$170). The MPT's explanation of such high charge is that the charge reflects the cost of an additional telephone line and the money collected is exclusively reserved and used for the network expansion. The China's average monthly subscription charge was US$4.8 for the business compared to the average US$7.0 for regional lower income countries (regional average US$10.0); and US$3.9 for the residential compared to the average of US$4 for the regional lower income countries (regional average US$6.0); and local call charge was around US$0.035 for both the business and residential compared to the average US$0.07 for the regional lower income countries (regional average US$0.08). Although China's monthly subscription fee and local call charges are lower than the regional average (which may well suggest that the MPT's international business is subsidising domestic usages), its total annual local telephone service costs for a residential subscriber based on the ITU formula was US$298 a year accounting for 83.5% of China's GDP per capita, the highest in the region compared with lower income countries in the region.

In 1991 China had a total number of more than 531,000 full-time staff employed in telecommunications services. But its telecommunications productivity was very low with only 16 mainlines per employee (regional average 68), ranking below Philippines (37), Thailand (63), Sri Lanka (17), Malaysia (63), Indonesia (31), Pakistan (21), only two lines more than India (14). In terms of revenue per employee, China ranks badly with just $5,027 revenue per employee, far, far below the regional average $51,025 and even lower than the Philippines, Thailand, Sri Lanka, Malaysia, Indonesia, Pakistan, India. (13)

Table 4

China's International Traffic & Call Charges Against Selected Asia-Pacific Countries
- Cost of 3 Minute Direct-dialled Standard Rate Call -
As of 1991

	China's Outgoing Traffic (To) (M Min.)	China's Incoming Traffic (From) (M Min.)	Traffic Imbalace To China (%)	China's Outgoing Charges (To) (US$)	China's Incoming Charges (From) (US$)	% of Cost of call From Opp Direction
Regional OECD Countries						
Australia	5.0	10.0	-100	9.9	7.3	36
Japan	13.0	62.0	-377	6.8	5.5	24
New Zealand	1.0	0.5	+ 50	11.0	5.7	93
Average	6.3	24.2	-284	9.2	6.2	48
Regional Upper Income Countries						
Singapore	14.0	4.0	+250	9.2	5.7	61
Hong Kong	305.0	380.0	-25	6.2	3.7	68
South Korea	4.0	2.0	+ 50	6.8	1.3	423
Macau	19.0	21.0	-11	6.6	1.3	400
Average	85.5	101.8	-18	7.2	3.0	140
Regional Lower Income Countries						
Bangladesh	0.5	0.5	0.0	9.2	6.0	53
Fiji	0.5	1.0	-50	11.0	7.1	55
Indonesia	0.5	1.0	-50	10.0	8.0	25
Malaysia	1.0	1.0	0.0	11.0	6.5	69
Pakistan	0.5	0.5	0.0	9.2	7.6	21
Philippines	1.0	1.0	0.0	11.0	6.6	67
Thailand	2.0	2.0	0.0	11.0	5.9	86
Average	0.9	1.0	-11	10.3	6.8	47

Source Adapted from *Asia-Pacific Telecommunication Indicators*, ITU, May 1993

Table 5

China's Local Telephone Service Costs
- Selected Major Cities -
As of August 1993, US$

	Shanghai	Tianjin	Hangzhou	Shenzhen	Wuhan	Yichan	Fuzhou	Shijia-Zhuang	Jinan	Average
Connection										
- Business	867*	841	867	780	1040	1261	780	815	1040	921
- Residential	607	600	607	780	693	1127	520	555	520	668
Monthly Subscription										
- Business	6.1	4.0	3.5	4.3	7.1	5.4	3.5	2.6	5.8	4.7
- Residential	5.6	4.0	3.5	2.4	5.7	5.4	2.8	1.7	4.0	3.9
Local call										
- Busniess	0.025	0.025	0.035	0.017	0.055	0.035	0.025	0.036	0.063	0.035
- Residential	0.017	0.025	0.035	0.017	0.035	0.035	0.025	0.036	0.046	0.030

Note (*) Exchange Rate of US$=5.77 Renmimbi Yuan as at the August of 1993 is used
Source Adapted from Chinese MPT's newspaper "Renmin Youdian" (People's Posts & Telecommunications), 26 August 1993

The range and quality of services are not much better than before, particularly, in inter- and intra-provincial calls, despite the network digitalisation. Taking for example Guangdong, Hainan, Inner Mongolia and Hubei provinces, the average successful call rate for automatic intra-provincial outgoing traffic was 32% in 1990, 26% in 1991 and 29% in 1992, for incoming traffic 43% in 1990, 41% in 1991 and 42% in 1992, while the successful rate for the automatic inter-provincial outgoing traffic was even worse, about 1% in Hainan province during the specific test and about 5% in the whole Guangdong province. In terms of local calls, the busy attempt failure rate accounted for over 30%, in some areas, up to 50% due to a limited number of long distance telephone circuits and severe congestion of local calls. Average successful call rate in international incoming calls is only about 35%. (14) The large number of unconnected calls have adversely affected customers and thus lowered the social and economic efficiency. The degree of network digitalisation therefore does not necessarily mean network efficiency if productivity is not improved.

5. NEED FOR INSTITUTIONAL REFORM

"*In the changing global telecommunication environment, every country needs to undertake a comprehensive re-evaluation of its telecommunication sector*". (15)

Despite its importing and adopting the most advanced and innovated telecom technologies, China has made little changes in its incompatible institutional structures that have increasingly become a potential bottleneck to driving China into the information age of the 1990's and beyond. The operational inefficiency in China's telecom network can largely be attributed to the lack of the corresponding institutional reform.

5.1 Organisational Weakness

Like other industries in China, telecommunications institutions have a reputation for their complex, intrinsically and viciously competitive political, bureaucratic and personal interests which outsiders cannot imagine. It is vividly and rightly described by some as "a house of mirrors with no central focal point; or a maze of punishing possibilities with no clear or straightforward solution". (16)

On the top, the State Council, a central and ultimate supreme policy-making body for telecommunications has responsibilities to develop a national strategy for semiconductor, computer and telecommunications industries. Under the Council is the State Planning Commission (SPC), a powerful apparatus, which reviews and steers industrial efforts and growth, and State Science & Technology Commission responsible for technology policy, development and acquisition including telecommunications. Another is Radio Management Commission largely controlled by the People's Liberation Army (PLA), a body little known until recently for its role for assigning spectrum for burgeoning mobile communications, with duty to manage the allotment and allocation of radio frequencies and to reconcile the conflicts of interests among different ministries in terms of using spectrum resources. Under the Council and the SPC, the MPT is mainly responsible for the public network of interprovincial and international telecommunications. The Ministry of Electronics Industry (MEI), an arch rival of the MPT, is responsible for communication equipment but with a greater operational control over manufacturing in telecom equipment. Ministry of Finance controls the pricing of telephone services. Thirty or so private network ministries or corporations, such as Ministries of Railways, Petroleum, Water and Power, Coal, Astronautics, the PLA, Bank of China and other Government bodies, which, with different needs and special purpose, have created or are creating or will create private networks independent of the national public network. Last but not the least, provincial, municipal and rural authorities have responsibility for formulating and implementing local development plans. Due to the decentralisation process, these local PTTs have now become more powerful players over which the central government and MPT seem to have less control and influence.

5.2 Historical Perspective

In fact, China has made several institutional changes since the Communists took over in 1949. In the early 50s, the MPT was established as a major policy and decision maker over national telecoms network. In 1958, the power of MPT was decentralised to local governments who played a leading role in network expansion. In 1961, MPT was given its power back again. In 1971, MPT was dissolved and transferred to Ministry of Communications with the whole network under the PLA's control. In 1973, MPT was reinstated but with local governments leading the way. And finally since 1980 MPT has been given chief functions to plan, expand and manage the interprovincial long distance network and to make and promote technical standards with local PTTs under dual leadership of both MPT and provincial governments. (17) The frequent changes with regard to the MPT, the lack of an unified, authoritative and coordinated monopolist plus the mentality of industrial self-sufficiency on the part of bureaucracy had in the past caused the underdevelopment of the public network while encouraged the network duplication and hence drained and wasted the national scarce resources.

5.3 Shifting Towards MPT

Increasingly, the Chinese government has realised that telecommunications by nature is technology and capital intensive industry and the proliferation and duplication are unaffordable as to modernise its very low based infrastructure. Also, recognising the importance and expertise of comprehensive modern network management, the Government has for the past few years increased the MPT's power and control over telecom planning and development. Since mid 1980s the central government has no longer financed any network construction or upgrade for user ministries (except the army) who must almost exclusively rely themselves on funding. Whereas, the MPT has enjoyed large amount of capital injection. The first joint venture with Belgium company to produce modern switching system S12 was given under the MPT's control. The MPT's position has been further strengthened by the statement of Vice-Premier Zou Jiahua during the Seminar attended by all provincial PTT Directors and MPT officials held August 1993, that "during the current structural reform, the State Council has clearly affirmed that the MPT is still a main important functioning body responsible for national telecoms. As a functioning organisation under the Council, the MPT must be accountable for the Council to well manage the national telecom industry, which consists not only those networks under the MPT's control and management but also those private networks under other organisations and units. They form a complete telecom industry". (18)

5.4 Decentralisation

As a process of national economic reform, MPT has also decentralised its decision power such as local network expansion and the importation of digital switching equipment to provincial PTTs. The latter has led the proliferation of various types of switching equipment as provincial governments themselves (not the MPT) helped by foreign soft loans are financing the local network expansions. So far China has imported eight different type of major switching systems installed in the network from Alcatel, Ericsson, NEC, Fujitsu, Northern Telecom, Siemens and AT&T, etc. Currently there are three sino-foreign joint ventures in making SPC switching equipment, Shanghai Bell (Alcatel of Belgium) under MPT, Tianjing-NEC Electronics Industry Co Ltd (NEC of Japan) and Beijing International System Company (Siemens of Germany), both under the MEI. China has recently signed two MoUs with AT&T and Northern Telecom to jointly produce digital switches in China. While China's market is big enough to have several major switching systems, it is doubtful that it justifies eight. Experiences of other countries would indicate that these may not fully explore the economy of scale and scope necessary for basic infrastructure development and could lead to incompatibility or high cost in solving technical adaptation problems, particularly, when the MPT is soon to equip its whole network with CCS7 signalling system.

Decentralisation has its merits whereby the incentives of provincial PTTs are stimulated and acute financing problems are partly solved, but it is not without drawbacks. For instance, local officials may be only interested in their own backyards; universal service throughout the country may be left as a secondary goal with infrastructure disparity between coastal and inland provinces, network expansions may be technically inconsistent, and network management ultimately discontinuous, if there is no strong unified, authoritative and coordinated national telecommunications leadership. The further problems may have emerged as China has decided and started to interconnect public network with private networks of different technical standards. The organisational decentralisation is thus by no means the most astute way for the MPT to plan and manage its infrastructure development and industrial competition may not work for basic telephone services where infrastructure needs have not yet been satisfied.

6. PREPARING THE GROUND FOR REFORM

The fundamental aim of China's telecommunications restructuring should be placed on efficient and productive running of the network where efficiency can be improved and economy of scale and scope realised. Melody has suggested three order conditions in the process for the effective restructuring of telecoms.

First order conditions "relate to the establishment of an institutional structure that clearly defines separate and distinct roles for policy-making, regulation and management". (19) The current key issue here for China's telecommunications is to separate operational management from the government so that neither politicians nor bureaucrats can interfere in operational decisions. At the time of writing, a proposal to separate governmental and business functions by making Directorate-General of Posts and Directorate-General of Telecoms (DGT) independent entities - a precursor for their corporatization - is under discussion within the government circle. So far, MPT has set up a data communication company under DGT and intends to set up a mobile communication company and phone card company also under DGT. MPT has also realised the necessity to separate posts and telecoms in response to the need to separately manage distinctly different requirement for capital, labor and technology for their efficient operation. Currently, it is only practical difficulties in separating county level PTTs that deter the MPT to act right now.

Second order issues in structural reform are concerned with access to essential resources – human, capital and technology in order to provide efficient services. "Technologically advanced telecom systems require highly skilled human resources throughout the organisations from top management to the 'shop floor'". (19) China, like most other developing countries, have shortages of both skilled management and technical labor in the provision of services. For instance, the shortage of trained engineers has led the Shanghai Bell company to scour universities to sign up students near to graduation at the time the company need to expand rapidly. (20) So, while attention must be paid to the structure of China's labour, capital and telecom technology markets, there is an immediate need to build and expand telecom education and training programs – technical, managerial, software design and maintenance, service development and marketing, economics, accounting and law.

Third order conditions are the role of competition. Competition is essential for the attraction of the necessary resources, efficient and up-to-date production and service delivery at reasonable prices, and full protection of consumer and public interests.

Although China's telecom network is still largely under MPT's monopoly, some of its service markets have been eroded or challenged. CPE market has been liberalised with only required technical approval by MPT for the purpose of network connectivity.

Competition is the fiercest in mobile communications which is often used as the best means to bypass the monopoly and meet the unmet demand from fixed telephone lines. According to the MPT, there are now 74 paging operators in Beijing, 49 in Shanghai, 20 in Kunming, Nanjing, Zhengzhou and other cities respectively. Nationwide, there are only 10 operators belonging to the MPT, while 160 operators are non-MPT's. The MPT estimated that by the end of 1993, the number of pagers will be 5.5 million, and total mobile phones in use 520,000. But because of the unregulated competition, the "air battle" seems to get out of control. Spectrum are used up, interference occurs. This has clearly demonstrated that legislation and regulations in telecoms are the important "rules of the game", which guide the conduct of and competition among stakeholders in the market place. Without any credible, fair and competent umpire, competition will go nowhere and only lead to regulatory and market confusion.

China is one of few countries that do not have telecommunications or communication law governing the industry. The MPT has recently submitted the draft of Telecommunication Law to the government. It is expected to be discussed and passed by China's legislative body, the National People's Congress by 1995. In order to create market certainty and fair competition, the Congress has passed an Anti-Unfair Competition Act effective from 1 December 1993. Last September the MPT also published the regulations to liberalise, under licensing system, value-added and new services such as radio paging service, 800MHZ trunked mobile service, 450MHZ radio mobile services, domestic VSAT service, telephone information service, computer information service, E-Mail, EDI, videotex and other services approved by MPT.

In August 1993, Lian Tong Company - a potential network competitor - jointly owned by the MEI, Ministry of Railways and the Ministry of Electric Power, was approved by Party Chairman Jiang Zheming (former MEI Minister) and Premier Li Peng. The Company seems unlikely to build a strong competitive network without foreign participation.

7. CONCLUSION

China's great weakness is its institutional tools for executing its deep and pervasive commitment to economic growth as the supreme aim of its national policy. The question is whether the thirst for growth is so strong that it will lead China to create the institutions that will eventually be needed to satisfy it. (21) The present organisational weakness and structural complexity are impeding the realisation of efficiency and productive expansion. The decentralisation, lack of market guidance and unregulated competition fail to fully exploit the benefits of new innovated technologies and economy of scale and scope commonly associated with telecom networks.

Apart from investment in basic infrastructure which China has done well, the other two more important factors are necessary for successfully modernising China's network, namely, investment in human capital and institutional reform that serves to permit the people of the society to have access to the infrastructure and to use their labor power, brain power and entrepreneurial energies in ways that create new wealth for the society. (22) China has begun to realise the importance of institutional reform and is now preparing to restructure its telecoms. However, whatever policy on structural reform China may adopt, one cannot expect China to change its telecommunications structure and open its networks to the outside world overnight, just as the world cannot expect western-style democracy suddenly to emerge in China. It is more realistic to expect evolutionary and progressive telecommunications reform, just as the world expects slow progress towards greater pluralism in the leadership – and it is in the interests of our region that reform occurs evolutionally in a reasonably calm atmosphere and orderly manner.

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NAFTA and Telecommunication Opportunities in Mexico

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1.ABSTRACT

The implementation of the North American Free Trade Agreement (NAFTA) between Canada, Mexico, and the United States in January, 1994 significantly impacts the telecommunication industry in Mexico by eliminating barriers to trade and facilitating foreign investment. This paper summarizes the relevant chapters of the treaty, examines several strategic partnerships between Mexican and US companies, assesses the Mexican cellular market, one of the most promising business opportunities in the sector, and concludes with an analysis of the future of the telecommunications industry in Mexico.

2. A BRIEF OVERVIEW OF THE MEXICAN TELECOMMUNICATIONS INDUSTRY

The North American Free Trade Agreement (NAFTA), a treaty between the United States (US), Mexico, and Canada which eliminates trade barriers over a 15 year period, was implemented on January 1, 1994. With its ratification, windows of opportunity are being opened for many industries on both sides of the Mexico/ US border. This is especially true of the Mexican telecommunications market, where lagging technology and inadequate standards of service prompted President Carlos Salinas de Gotari to put telecommunications at the forefront of his 1989-1994 national development plan. In the early and mid 1980's, the industry was self- admittedly in urgent need of help. It took an average of three years to activate new telephone lines, while requests for installation and complaints about existing services were mounting. And up to only four years ago, FAX service was nearly non-existent as restrictions on imports impeded their entry into the country. By the late 1980's however, it became apparent to the Mexican government that if Mexico were to both develop into a world economic power and attract the foreign capital it would need to do so, a modern telecommunications system was an absolute necessity.

To this end, the Mexican government put into action a series of measures meant to reform this essential area of the economy. These measures have led to a radically altered telecommunications environment in Mexico; an environment, however, that leaves much room for business opportunity. This paper examines the new era of the Mexican telecommunications industry, outlines the pertinent passages of NAFTA that apply to this area of the economy, describes several partnerships that have recently evolved between US and Mexican companies, and assesses one of the most promising sectors of the Mexican economy, the cellular market. Finally, the paper concludes with an examination of the future of the telecommunications industry in Mexico.

3. NAFTA AND SERVICES TRADE

Since telecommunications is as much a service industry as it is an equipment industry, it is important to realize that NAFTA liberalizes services trade by establishing three broad principles. The first is non- discrimination, whereby all NAFTA parties agree not to give preferential treatment to local firms. The second is the provision of cross- border services, which states that, with few exceptions, US firms may provide services in Mexico and Canada without relocating from their present sites. The third and final principle eliminates the citizenship requirements for the licensing of professionals, such as engineers, marketing/sales personnel, and accountants. This subsequent harmonization of professional service standards which NAFTA promotes will increase the ease at which service trade can flow among the treaty's participants, thus facilitating further cross- border trade and commerce.

4. NAFTA: TELECOMMUNICATIONS EQUIPMENT AND SERVICES

NAFTA eliminates discriminatory restrictions on US sales to and investments in the over $8 billion Mexican telecommunication equipment and services market. It opens opportunities for US exports of equipment to Mexico, which totalled $794.2 billion in 1991, and rose to be in excess of $963.8 billion in 1992.(1) In addition, the agreement permits the US export of enhanced services to Mexico, a market expected to grow from $22M in 1991 to over $100M by 1995. NAFTA eliminates investment restrictions in most enhanced services immediately, while removing all restrictions in their entirety on packet-switching services by 1995. The treaty not only allows US firms to operate state of the art, private intra- corporate communications systems throughout North America but also guarantees US parties access to public communications facilities while doing business in and with Mexico. And finally, NAFTA eliminates product standards as a barrier to telecommunications trade by providing for mutual recognition of test data from all competent test facilities in NAFTA countries. The following is a brief description of the relevant passages in NAFTA which impact the telecommunications industry and trade.

4.1 ACCESS TO AND USE OF PUBLIC NETWORKS

NAFTA ensures that the three participating countries will provide reasonable conditions of access to and use of public networks to include the ability to lease private lines, to attach terminals or similar equipment to public networks, to interconnect private circuits to public networks, and to perform switching, signalling, and processing functions. A user will also be able to choose his or her preferred operating protocol. Both enhanced and value added telecommunication services and intracorporate communications are included in such uses, but the operation and provision of public networks and services do not fall under the jurisdiction of the NAFTA.

Conditions on access and use may be imposed only if necessary to safeguard the public service responsibilities of network operators or to protect the technical integrity of public networks. Examples of such may include restrictions of the resale or shared use of public telecommunications transport services, requirements to use specified technical interfaces with public networks or services, or restrictions on the interconnection of private circuits to provide public networks or services. Rates for public telecommunication transportation services must reflect economic costs, and private leased circuits must be available on a flat- rate pricing basis. NAFTA does not, however, ban cross- subsidization between public telecommunication transport services. Both firms and individuals may subsequenly move information, both within a country or across NAFTA borders, through the use of public networks and services. It should be noted that the above- mentioned provisions in the telcommunications chapter do not apply to measures affecting the distribution of radio or television programming by broadcasting stations or cable system, each of which will have continued access to and use of public networks and services.

4.2 EXCLUSIONS AND LIMITATIONS

The United States, Canada, and Mexico are not required to authorize a person of another NAFTA country to provide or operate telecommunications transport networks or services and may prohibit operators of private networks from providing public networks and services.

4.3 ENHANCED TELECOMMUNICATIONS

The NAFTA provides that each participating country will ensure that its licensing or other authorization procedures for the provision of enhanced or value- added telecommunication services are transparent, non- discriminatory, and applied expeditiously. Enhanced providers of the three countries will not be subject to obligations that are normally imposed on providers of public networks and services, such as providing services to the public generally or cost- justifying their rates.

4.4 STANDARDS- RELATED MEASURES

NAFTA limits the types of standards-related measures that may be imposed on the attachment of telecommunications equipment to public networks. Such measures must be necessary to prevent technical damage to, and interfere with, public networks and services, to prevent billing equipment malfunctions and to ensure user safety access. In addition, any technically qualified entity will be permitted to test equipment to be attached to public networks. This section also establishes procedures in each country to permit the acceptance of equipment test results conducted in other NAFTA countries.

4.5 MONOPOLY PROVISIONS OF NAFTA

NAFTA recognizes that a country may maintain or designate a monopoly provider of public networks or services. Each country will ensure that any such monopoly does not abuse its monopoly position by engaging in anti- competitive conduct outside its monopoly that adversely affects a person of anther NAFTA country.

4.6 PROVISION OF INFORMATION

NAFTA strictly stipulates that all information related to access and use of public networks and services must be available to the public. Examples of such include the presence and level of tariffs and other conditions of service, network specifications, service technical interfaces, information of standardizing organizations, conditions for the attachment of terminal or other equipment, and the requirements for modifications, permits, registration, and licensing.

4.7 TECHNICAL COOPERATION

NAFTA encourages participating parties to cooperate in the exchange of technical information and in the development of government to government training programs. NAFTA also recognizes the significance of global telecommunications standards, and thus promotes such standards through the work of the International Telecommunication Union, the International Organization for Standardization and other similar international groups.

5. FACTORS THAT INFLUENCED SOUTHWESTERN BELL'S INVESTMENT IN TELMEX

Until 1989, Mexico's telecommunication industry was under strict governmental control. Telefonos de Mexico (Telmex), Mexico's second largest company which regulated tele-communications throughout the country, was completely managed by the Secretaria de Communicaciones y Transporortes. The SCT, as the agency is known, retained 56% of Telmex's shares, established technical standards, managed the company's investments, set the rates charged to clients, and even held the presidency on the board of directors. However, with the rapid changes that occurred throughout the Mexican economy during the 1980's, coupled with the importance President Salinas placed upon the role of telecommunication in his effort to modernize Mexico, control of Telmex was relinquished to a group consisting of the Mexican holding company Grupo Carso, a division of France Telecom, and Southwestern Bell, in December of 1990.

For Southwestern Bell, there were 5 major factors which influenced their decision to bid on Telmex. First was Mexico's business environment; it both provided a climate of reasonable stability in regards to government policies affecting telecommunications and was similar enough to US business practices that incompatibility of such was not a problem. For example, US and Mexican accounting principles are relatively identical, as are most financial reporting standards. Second was the Mexican government's clear definition and understanding of its objectives, which include:

a) developing a world class telecommunications network that would cultivate economic growth;
b) increasing the quality and quantity of services throughout the country;
c) keeping control of the company in Mexican hands;
d) attracting buyers with a commitment to these goals and an ability to achieve results;
e) receiving a fair sale price;
f) drawing other foreign investors to Mexico.

Third, Telmex's selection of key partners had a significant impact upon the outcome of the enterprise. In any investment venture, chosing associates with proven experience, leadership, and integrity reduce risk and enhance long term probability of success. Headed by chairman Carlos Slim, Grupo Carso of the Mexican contingent is a global business leader with domestic clout and financial resources, while France Telecom is on the cutting edge of advanced telecommunications technology. Both brought to the endeavor a proven track record and a great deal of applicable experience.

Telmex's financial needs were another relevant factor to Southwestern Bell. Prior to investment, the surging Mexican economy placed great strain upon a technically inadequate infrastructure and unsatisfactory quality of service. With the capital that the acquisition provided, Telmex's budget, along with its subsequent ability to deliver a higher quantity and quality of service, significantly increased. Expenditures for the company during 1991- 1995 will amount to $14.149 billion, including $1.324 billion for telephone equipment, $2.663 billion for transmission equipment, $3.940 billion for exchanges and power, and $3.695 billion for outside plant. By the end of 1994, Telmex plans to have 8.55 million installed lines, and 9.62 million in 1995. By 1995, if projections remain valid, Telmex will have reached a telephone density of 10.76 lines per one hundred people, a marked improvement, yet one that is still only half that of the average developed country. In January of 1993, there were 6.3 million lines installed, 12.8 million telephone apparatus active, and 14,600 towns of more than 500 people with access to telephone service.(2)

And finally, the geographical proximity of Mexico was another major factor in Southwestern Bell's decision to bid. The US company operates in Texas and shares a 1000 mile border with Mexico. Because in part of this proximity, Southwestern Bell is comfortable with the Mexican culture and business philosophy, with more than 20% of its labor force consisting of Texan Hispanics. In addition, the company has recently relocated its corporate headquarters to San Antonio.

6. ANOTHER MAJOR MERGER: THE BELL ATLANTIC AND IUSACELL VENTURE

In addition to the success that the Southwestern Bell partnership found in the Mexican telecommunications market, another significant relationship has evolved between a US and Mexican firm which could very well prove to be just as profitable. Bell Atlantic, a Baby Bell company based in Philadelphia, has been permitted to purchase 42% of Iusacell, a Mexican telecommunications firm, for $1.04 billion by terms of an agreement signed Oct. 11, 1993. Iusacell, the second largest telecommunications company in Mexico, is licensed to provide two-thirds of the cellular service of the country's 82 million residents and also has a nation-wide radiotelephone licence. The capital that Bell Atlantic's investments infuse into Iusacell will be applied to both expanding the company's cellular customer- base and improving traditional telephone services through the development of a wireless telephone network.

Projections for the growth of Iusacell are encouraging. Revenues between 1990 to 1992 increased by 76% to $253 million, while during the same time period company's net profits rose to $32 million, over a 400% increase in two years time.(3)

This venture offers Bell Atlantic several opportunities in vast and growing markets. One of the most significant is the Mexican cellular market. Because traditional land- based lines throughout the country are often unreliable, if they are present at all, the potential for cellular telecommunication is obvious. This potential will continue to expand as Mexico's need for a dependable means of local, national, and global communication increases. Since the service became available in 1989, subscription rates have been increasing dramatically. In 1990, there were 45,000 subscribers, 130,000 in 1991, and 230,000 in 1992. In addition, by the end of 1994, there is expected to be over 400,000 subscribers across the country and the service will be available in 145 cities. With the increased demand and subsequent usage of cellular telecommunications in Mexico comes a subsequent increase in demand for cellular equipment. In 1990, the Mexican market for this type of equipment was $78.4 million, $102.6 million in 1991, $116.8 in 1992, and is expected to grow an annual rate of 6% for the next three years. (4)

Other areas of opportunity exist for Bell Atlantic in Mexico, namely that of traditional telephone services. In Mexico, there are presently only 8 phone lines per 100 people as compared to 65 in the United states and 85 in Canada. The Mexican market for telecommunications equipment in 1992 was $2,268.9 million, and is expected to grow 10% annually.(2) The Iusacell venture provides Bell Atlantic with the leverage to access not only this area of the industry, but also, in three years, Telmex will lose its monopoly on the long distance market and thus open it up to competition. Bell Atlantic will undoubtedly be placed in a strong position to take advantage of all windows of opportunity in the Mexican telecommunications industry.

7. CELLULAR TELECOMMUNICATIONS IN MEXICO: A FUTURE OF OPPORTUNITY

The cellular services and equipment market in Mexico remains as one of the most growing and profitable sectors in the country. As previously mentioned, by the end of 1994 there will be a projected 400,000 subscribers in Mexico, with a expected growth rate of 50% for the next several years. Cellular telecommunications equipment is also expected to expand at an annual rate of six percent. Although fierce competition exists within the sector, most assessments of the market suggest that Telcel, the cellular subsidiary of Telmex, has achieved a 50% market share and will remain in a dominant position for some time to come.

The structure of cellular service in Mexico is based upon a SCT decision to divide the country into nine distinct regions; applications were then submitted by interested parties to bid for their cellular rights. Each of the regions has a transmission link termed band A (840-860 Mhz.). A few of the regions who have a large number of subscribers also use a second link termed band B (920-940 Hhz.). The licences for band A were made available by the Mexican government for bidding. However, all band B licences were given to Telcel. Of the 107 applications presented to the SCT, ten were awarded- one for each of the nine regions, and one to Telmex for nationwide access. United States companies are immediately involved in six of the regions, and foreign investment of the eight, non- Telmex companies situated outside Mexico City averages 40%.(5)

With the passage of NAFTA, an already accessible Mexican market for cellular telecommunications will become even more attractive. Two licence requirements are needed, however, for products to be permitted into the country- a Mexican Official Standard (NOM) approval, and a Homologacion approval. NOM requirements are based upon meeting the quality and technical standards of the Secretary of Commerce and Industrial development. Homologacion certification, a requirement for all devices which are either connected to public telephone networks or use the radio electric spectrum, are used to ensure that equipment meets Mexican specifications.

The following is a summary of the NAFTA schedule of tariff elimination for tele- communication and telecommunication- related products.

NAFTA tariff reduction schedule:

Item	Category
Manganese dioxide alkaline bat.	C
Mercury oxide alkaline bat.	C
Silver oxide alkaline bat.	C
Other alkaline bat.	C
Telephones with special features	B
Other devices for telephony	A
Modems	A
Antennas, except Radio, TV or parabolic	A
Ferrite rods for antennas	A
Parts for antennas	A

Category A:
Duties will be fully eliminated on Category A products on January 1,1994

Category B:
Duties on category b items shall be removed in five equal stages of 20% of the base rate. This reduction will begin on January 1, 1994, with full duty elimination on January 1, 1998.

Category C:
Duties shall be removed in ten equal stages based on an annual reduction of 10 percent of the NAFTA base rate beginning on January 1, 1994, leading to a duty elimination on January 1, 2003.

8. BEYOND 1994: WHAT LIES AHEAD IN MEXICAN TELECOMMUNICATIONS

The unquestionable success of cellular solutions for Mexico's still unmet telecommunications demand clearly illustrates the market's receptivity to new technology and services. The overall growth that has occurred in the Mexican telecommunications sector, complemented by the elimination of trade barriers that NAFTA enacts within the region, assures that Mexico's telecommunications industry will continue to exhibit both high earnings and growth for sometime to come. In addition, the access to services which NAFTA sets a precedent for by establishing principles of non- discrimination, ease of cross- border services, and no citizenship requirements, further facilitates trade.

Furthermore, the technological polarity of Mexico's telecommunication infrastructure when compared to that of the United States permits vast potential for the trade of both services and equipment. This potential is highlighted by the fact that by 1996 Telmex will lose its monopoly on long distance service, opening up another quickly expanding market. Indeed, large corporations and entrepreneurs alike are already positioning themselves for this event, foreseeing Mexico's huge potential market for long distance services dramatically increase as the country dives headlong into the international trade arena.

FOOTNOTES

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COMPETITIVE TELECOMMUNICATION ENVIRONMENT IN A DEVELOPING ECONOMY - THE EXPERIENCE OF A CHILEAN CARRIER

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VTR is the only Chilean telecommunications carrier who has been private ever since its foundation. It offers services such as telex, telegraph, data transmission, electronic mail, fax store & forward and, more recently, long distance telephony. Below is a description of the situation of this last service, its regulatory process as it stands now and the consequences of the delay in its implementation from the point of view of one carrier. Also described is the potentiality of the market, its tough competition and how this particular carrier is confronting it.

1.- HISTORY

Like many countries in the world, telecommunication services in Chile were provided, at the very beginning, by a number of private companies, operating in a competitive market. As services evolved with the introduction of more complex telephone networks, so did the regulatory framework. Regulations were issued to enable customers of different networks to communicate with each other and to optimize investments.

Subsequently, the majority of these companies became property of the Chilean government.

This process was reverted in the mid eighties, with the privatization of the two main telephone companies and the acquisition by a private company of the telex business. This last one was being handled by the National Post Office at that time and was separated from the mail service once the acquisition took place.

2.- TRANSRADIO CHILENA (VTR)

One of the first telecommunication companies in Chile was "Transradio Chilena Compañía de Radiotelegrafía Limitada", founded in 1928 to provide domestic and international telegraph services. Along the years, it introduced other telecommunication services, including telex, data transmission, electronic mail and a fax store-and-forward system.

This company also grew by acquiring other related companies, such as "ITT Comunicaciones Mundiales", to become one under the name of Via Transradio (VTR), a market leader in providing telecommunication services to the business community in Chile. Another interesting fact is that VTR is the only company, of the "historical ones", that has always remained private.

3.- COMPETITION IN TELECOMMUNICATIONS IN CHILE

For some types of services, namely telex and data transmission, there has always been competition in Chile, even when one of the competitors,in the case of the telex, was state owned.

At the present moment, two companies compete for the telex market : Télex Chile, which was formerly part of the PTT, and VTR Telecomunicaciones.

The packet switching service, which started in 1986, also has two main competitors : Chilepac (a subsidiary of Télex Chile) and VTR. More recently, subsidiaries of ENTEL and CTC have entered this market with the idea of providing a whole set of services to the customers.

As for competition in the telephone service, until 1992 it had been very limited. Before that, a few small telephone companies offered (and still do) local services in some areas of Santiago and Valparaíso, competing with CTC, the biggest one. In the rest of the country, remains a geographical subdivision between CTC, which has 95% of the market, and CNT which operates in two of Chile´s southern regions.

4.- THE TELEPHONE SERVICE

In 1980 there were two main telephone companies in Chile, both state owned : Compañía de Teléfonos de Chile (CTC) and Empresa Nacional de Telecomunicaciones (ENTEL), the latter being created in 1964 to provide long distance services. As mentioned before, a few small companies operated in some areas.

At that time, CTC operated the local market throughout the whole country, with the exception of two southern regions, and ENTEL operated both the domestic and international long distance service. While CTC had some small companies competing for the local service in some areas of Santiago and Valparaiso, ENTEL enjoyed a situation of monopoly, being the only long distance carrier in the country.

The service evolved gradually, both quantitative and qualitative, with the economy of the country, but not as expected in terms of user density. By that year, in fact, Chile had a little more than 7 telephones per 100 inhabitants, a density well below those of other Latin American countries. Although it was also due in part to the geographical configuration of the country, it was considered as being too low.

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In the mid eighties both CTC and ENTEL were privatized, leaving the entire telephone sector in private hands. The competition in the long distance market began in August of 1992 when Chilesat, another subsidiary of Télex Chile, opened its international operations. Later, in April of 1993, VTR Telecomunicaciones appeared as a new long distance carrier. All of this led to a number of events that are now pushing the sector into a fully competitive environment, whose rules, however, are still to be clearly defined.

5.- THE REGULATORY ENVIRONMENT

Chile did not have a specific law on telecommunications until 1982, when the "General Law on Telecommunications" was approved. This law is still in force today, although it has been modified, mainly in the areas of radio and TV broadcasting. The law defines the rules by which companies can apply for licenses and specifies the governmental procedures to grant them.

It basically specifies three types of licenses:

- public license, which allows a carrier to offer the service to the general public;
- intermediate license, allowing carriers to offer the service only to other carriers, namely public ones;
- limited license, for services which are limited to a well defined set of users in a particular geographical area.

Under this scheme, for example, VTR, together with other companies, has public licenses for the telex and data transmission services together with other companies, while CTC has a public license for the telephone service, as well as other local companies. On the other hand, ENTEL has an intermediate license that allows it to offer the service to the public companies, and therefore only indirectly to the public.

When applying for a license, a company must specify, other than the service it wants to offer, the equipment it will use for providing that service, and its location. Any change in the equipment must be approved and requires a modification of the license. This is the reason for which a license does not grant by itself the right to provide a particular service everywhere, but it restricts it to the equipment approved in the technical project.

6.- COMPETITION IN THE TELEPHONE SERVICE

As mentioned before, some competition existed in the local telephone service, although very little, but did not exist in the long distance service until 1992, when licenses were granted to Chilesat and VTR, adding two competitors to ENTEL. These licenses, however, were "intermediate" licenses, not allowing direct access to the users.

The only way these two companies could operate was by supplying the service to local companies, namely CTC because of its importance and market share. This could be done by negotiating quantities of traffic with the local company, which would actually be the one to decide the market share of the three long distance carriers. Moreover, the end user did not benefit from the competition because he or she had no way of choosing the long distance carrier, and therefore the price and quality of the service. Things became more complicated when CTC itself decided to enter the long distance market.

As a small background of this situation, CTC, after being privatized, seeked for a license for long distance telephone service. Before granting it, and as part of the normal procedure, the government authority, namely the Ministry of Transport and Telecommunications, asked for the opinion of the Anti Trust Commission, to see if this license would lead to a monopoly situation, due to the fact that CTC already had 95% of the market. This opened a more general debate on whether local companies should be allowed to enter the long distance market, and viceversa.

After a long series of discussions which took a number of years in various Commissions and Courts, it was ruled that CTC could provide long distance telephone services without the risk of monopolizing the market but only if a number of conditions were satisfied. These conditions implicated actions to be taken by both the company itself and, more importantly, by the government, for which a timeframe of 18 months was given. However, this ruling found its opposition in the various companies involved in the debate, having each its own reasons. Because of this, the whole question is presently being reviewed by the Supreme Court.

In the meantime, the government has presented a new modification to the Law of Telecommunications with the aim of allowing a competition that would actually benefit the user. This modification is being discussed in the Congress, and contains many of the recommendations of the Anti Trust Commission.

Basically, this modification aims to allow the user to be able to select the long distance carrier he or she prefers. It obliges the local telephone companies to implement the "dial-a-carrier" facility, i.e. a carrier code that will precede the dialed number to indicate the selected carrier. Optionally, the possibility of electing a default carrier once and for all should also be implemented, leading to an "equal access" very similar to the U.S. model.

The fact that the modification of the law also deals with the very controversial issue of the participation of the local companies in the long distance service has long delayed its approval, leaving the whole point still (November 1993) undefined.

This has damaged the new companies, because they cannot offer the end user the possibility to access their services, being restricted to bulk agreements with the local telephone companies, of which CTC is obviously the most attractive, handling 95% of the traffic. It has also damaged ENTEL because its traffic has decreased without them being able to reverse this trend utilizing the traditional market tools.

7.- THE ACTUAL SITUATION - THE CASE OF VTR

With the absence of a clear regulatory environment that would permit full competition in the long distance market, and with its new equipment (an Earth Station and an International Telephone Switching Center) ready to operate, VTR had to find a way to enter the market and obtain (or maintain) market share. This is particularly important in the case of international traffic, because a good market share is a must when negotiating with carriers from other countries.

With the impossibility of the general user to choose VTR for its international calls, the company had to restrict itself to a selected business market. This was done by means of an agreement with a local company operating in some districts of Santiago. With this agreement, the local company allows its users to select, if they wish and once and for all, VTR as long distance carrier.

This agreement made it possible for VTR to start selling its new service, even with a geographical limitation which is the area where this local company operates. This limitation, although limits the possibility of offering the service to the general public, is not as big as it may seem, because 80% of Chile's international traffic is generated in Santiago.

The possibility of reaching the general public will come with the approval of the new law and the consequential implementation of the "dial-a-carrier" facility, foreseen by mid 1994. By that time, VTR will hopefully have gotten a significant market share among its business users, which will facilitate the penetration in the residential market.

8.- PRICES AND TARIFFS

The telephone service is still considered a monopolistic service in Chile. In fact, CTC with its 95% of the local market and ENTEL, with 100% of the long distance until last year, constitute a de facto monopoly. Under this situation, the government establishes a top limit for the tariffs, both local and long distance. These top tariffs are calculated on the basis of a theoretically efficient company handling a similarly dimensioned service, and are automatically updated to assume the inflation. Every five years there is a redefinition of the efficient company under the new conditions, and new top tariff bases are calculated.

Although these tariffs are the highest permited, there being no competition they were obviously the ones applied. And even now, with more than one company in the long distance market, they are still applied to the general telephone service, because the user cannot select its long distance carrier. So, even if a long distance carrier could agree special prices with a local telephone company, this benefit could not be passed on to the user because its call is randomly routed between the carriers and he cannot be charged a "random" tariff.

9.- THE FUTURE

The new law should clarify the scenario, by dictating the rules for the competition. It will also create a new controlling entity, or "Superintendencia", that should grant the correct application of the rules. The timeframe for this, however, is not sure because even if it is foreseen for mid 1994, the past experience shows that this date can move farther away. Moreover, the outcome is still uncertain, as to the fact that the local companies might participate in the long distance market is still under discussion, and is the main delaying factor. The difficulty of finding an agreement between the political forces is also leading the government to trying to find different compromise solutions, making things more complicated. It is therefore very difficult for the carriers to make plans in this uncertain scenario.

Ideally, before granting licenses for long distance carriers, the government authorities should clearly define the rules of the game, such as who can participate; how many licenses can be granted in a given timeframe; how will the user access his carrier; and other similar rules to implement an effective and not only theoretically competitive environment. In the absence of this, the companies are adapting themselves to the situation that's within the framework of the existing law and its interpretations. This fact might create a situation that will be difficult to change in the future, even with a law.

Nevertheless, many companies are willing to risk entering this market, and this benefits the Chilean economy as it provides the customers with a wide variety of telecommunication services at competitive prices. This is possible, of course, only if there is true competition, without the establishment of de facto monopolies.

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TELECOM LIBERALISATION IN INDIA
STATUS AND ISSUES

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The paper discusses the causes for and course of liberalisation, and de-monopolisation in India's Telecom Sector and the current status and goes on to state what is likely to happen.

1. **INADEQUATE TELECOMS:**

1.1 Since Independence in 1947, India's telephones increased 88- times from 80,000 to seven million but in the same period, waiters for telephones increased 150 times to three million and the waiting period rose from two years to seven ! Varieties of new services like cellular and trunked mobile radio telephones, radio-paging, voice and E-Mail,store and forward fast FAX, high-speed digital circuits for distributed data processing and on-line data base access are not available though sorely needed; telecom prices have been periodically raised so steeply that the telephone price index (for a basket of services) has been rising more than the wholesale price index contrary to the experience of most of the world's countries and despite telecoms becoming more increasingly electronics-intensive. Besides, the quality of service , reliability and response to customers' wants and grievances are far from satisfactory.

1.2 Since the 1980's there has been increased tempo of economic activity, dispersal of industry and birth of new businesses as a result of the growth of the middle and higher income populations, (about 150 million out of 850 million). There are now about a million P.Cs and they are growing at about 15 to 20 percent an year and there is an increasing awareness that these could be networked over telecom facilities for realising higher productivity and effectiveness in business. While the lack of telephones and other world-class and variety of telecom facilities and services were resulting in economic penalties, these were largely internalised, as the Indian economy was enveloped in protective barriers against global linkages. But since the middle of 1991, especially with the collapse of the USSR (which was the source of much of the Govt's ideological inspiration), the Indian economic and industrail policies have been undergoing tremendous reforms, the aim of which is globalisation involving end of monopolies, subsidies, controls on industrial activity and promotion of competition. In this new situation, the penalties due to inadquate and costly telecoms are no longer internalised but are telling upon the efficiency and competitiveness and growth of the whole economy . For example, the non-availability or high cost of a digital data circuit could lead to loss of an offshore software development contract. And then there is the desirability of providing access to a telephone, at least on a community basis, to the 550,000 villages in the 3.3m square kilometer territory of India both as a measure of social justice and the need to draw them into economic activity. The standard and invariable reason given by the service provider for all the inadequacies and deficiencies is lack of investment funds. But the real reason, as the Mail-land Commission put it, is "inadequacies in organisation and management rather than shortage of investment" (Para 22), as we shall see in the following paragraphs.

2. DEMONPOLISATION OF EQUIPMENT PRODUCTION:

2.1 The telecom regime in India is governed by the Indian Telegraph Act (ITA) 1885 which conferred on the (then colonial) state the exclusive privilege of establishing, and providing the telecom services and the Industrial Policy Resolutions (IPR) of the government of free India which while embarking upon a series of Five-year Development Plans, envisaged the public sector occupying "commanding heights of the economy". The ITA 1885 and IPRs were interpreted by the Govt. Department of Telecoms (DOT), (P&T earlier) to mean that production of equipment, establishment, ownership and operation of services , regulation (including price-fixation and arbitration over customer-service provider disputes) and policy-making should all be with itself- a truly totalitarian regime . Three government companies, each a monopoly producer of different products produced inadequate quantities of equipment of indifferent quality. None developed its own technology but imported successive generations of technology (eg: strowger, Cross-bar, and digital electronic switches; dry core paper-insulated; plastic insulated and then , jelly-filled cables; electromechanical and then electronic teleprinter etc). The productivity was poor and costs and prices were high.

2.2 But by mid-1980s, the newly established Department of Electronics (DOE) gained an upper hand over licencing and production of electronics-based equipment including the telecom equipments. By a creative interpretation of the IPRs, it licenced a number of non-DOT companies in the states and even in the private sector to produce customer premises equipments (CPEs) and arranged for making available to them foreign technologies. In 1984, the Government set up a registered society,Center for Development of Telematiques (C - D O T) which undertook research outside the DOT and designed a series of digital PABXs, and a series of digital central offices (COs) of increasing size and capacity. It actively poromoted the emergence of private sector companies to produce a variety of telecom equipments. Finally, by the end of 1990, monopoly in production of all varieties of telecom equipments was totally at an end. It was a great development considering that the ITA 1885 and IPRs and socialistic planning were still the ruling state philosophy.

2.3 There however remained one difficulty. The DOT was the sole purchaser from all the producers-monopsony. Private sector companies are competing with DOT's own companies. Initially there were psychological, procedural and rigidity-in-specification barriers and delays in accepting the products. In regard to CPEs which had come to be purchased and owned by the users themselves, type-approvals took long to come. Like in the UK or USA, India still does not have a type approvals body independent of the telecom operator (DOT) but much of the difficulty is gone,especially since 1992 when a new liberalised, globaly open economic and industrial policy is the official line. The last monopoly barriers against equipment production came down when the Govt. decided that any foreign made switches and transmission equipment could be purchased by the DOT provided it could satisfy its specifications through 'validation' tests. Now, all the world's heavy weights AT&T, Siemens, Fujitsu, Ericsson-are supplying their digital C.Os and are going to produce them in India.

2.4 The consequences of demonopolisation of telecom equipment production are dramatic. The prices have crashed-an electronic push-button telephone costs one-third; a digital switch per line costs 40%; a multi - access shared rural radio system costs one-fourth, and the telephone cables three-quarter the pre-demonopolisation prices ! The quallity and availability have remarkably improved. No longer does the DOT buy substandard equipment from its companies with "relaxed" specifications. No longer does it allow spread of supplies over "extended" period of delivery. The private sector companies have invested in six years much more capital in their factories than the DOT's companies in forty years ! Indeed, their production capacities are under-utilised by 50% because the sole buyer, DOT and its one "experimental" service company MTNL have not enough funds to buy ! (That is a new problem which could be solved by demonopolisation of network ownership and service provision as we shall see).

3. INVESTMENT MONOPOLY - SERVICE PROVISION:

3.1 The ITA 1885 (Section -4) allows the grant of licences to private companies to establish and provide telecom services. Under this provision, the colonial Govt. gave licences to set up telephone systems in a number of cities and also international telecoms (Cable and Wireless) to private companies. On expiry of the 50 year-long licences the systems were taken over by the Government in 1943. In post-independence India, the IPRs and socialism, with the latter's characteristic faith in state capitalism, ignored this section and pressed on with monopoly provision as a govt. department.

3.2 In the initial years the investment money came overwhelmingly from the general capital funds of the govt. but as faith in socialism increased,telephones came to be viewed as "elitist" and so the capital was to be found more and more by surplusses of the P&T itself. That meant pricing services far above costs. Also, the postal deficits were to be coverd by surplusses from Telecom, further increasing the telcom prices above costs. (It was only in 1985 that telecoms were seperated from the posts, thus removing the postal subsidy element from telecom prices).Self-financing or generation of internal resources was stepped up as follows:

Internal Financing as % of Total Investment:

Plan period	% Internal Funding
1951-56	21
1956-61	32
1961-66	39
1969-74	72
1974-79	100
1980-85	67
1985-90	86
1991	100

It is because of this "internal" resource generation that the telephone price index has been rising faster far than the whole-sale price index since 1980, continuously. About 45% of the per main line revenue per year is ot related to costs of service but purely is capital contribution from every subscriber, every year, for ever. The price-rises are unchecked, unquestionable unregaulated and non-justiceable because it is a government that is raising them. India has a Monopolies and Restrictive Trade Practies (MRTP) Commission but it's jurisdiction is limited to private companies (on the premise that Govt. or its monopoly companies can never be unfair or unjust). The rate-rises could not be so savagely severe that not all the investment funds could be realised from them. So the "planned" supply could not keep up with the demand. The result is that waiting periods and waiters for service increased- the latter as a fraction of those served went up from 16.5% in 1980, to 30.0% in 1985 and to 38% in 1991 and to 42% in 1993-a deterioration with tragic penalties and disabilities on the economy.

3.3 The young prime-minister, Rajiv Gandhi wanted the seperation of telecoms to be followed by corporatisation of telecoms so that they could be enterprising, customer-oriented for services and market-fed for finances. But the civil servants dragged their feet and only under threat, condescended to proceed "cautiously" by creating in 1986, as an '**experimental** ' measure a telecom services corporation, MTNL for two cities, seperated by 1500 km, to gain '**experience**' . Soon it was used to raise maket loans to supply capital funds to DOT and was looked upon only as such. The MTNL became a company more in name and less in its freedom or performance, making only a little difference in performance, constrained to perform far below its potential.

4. LIBERALISATION IN SERVICE PROVISION:

4.1 The rate-rises unrelated to costs, the collection of capital through telephone bills without compensation (dividend or interest) in perpetuity, the preoccupation of the DOT with the plain old telphone service to the total neglect of other telecom services required for businesses; the paradox of huge unfulfilled demand and under-utilised productive capacities of the manufacturers have focussed public attention and inquiry into whether and how the investment problem could be tackled.

4.2 Unable to provide services to the requirements and pressured by those who are goverment departments or Govt. owned corporations, the DOT was obligated to let go its monopoly in respect of some segments of users . The

Defence Services, the Railways, a wing of the Planning Commission (NICNET, a data network using VSATs covering the entire country), GAIL,ONGC (State monopolies in natural gas) etc., are allowed to have their own facility-based services. Banks and financial institutions (which are mostly owned by the Govt) are allowed to lease facilities (channels or circuits) from the DOT and build country-wide, intra-company voice and data networks. The DOE in its bid to promote off-shore software contracts for Indians, is allowed to set up I.D.R satellite earth stations, connect company sites by point-to-multi-point digital, TDMA microwave radio and provide data channels, independent of DOT and its foreign carrier company, VSNL. But these are all special requirement groups whose lot has somewhat improved because of a small merciful easement of monopoly. Their requests for interconnection of their private networks (permitted by a CCITT recommendation) is not acceeded to by the DOT-not as yet. The relief on DOT's investment requirement due to these is not much-less than 1% but the impact on the idea of monopoly is significant.

4.3 The various manufacturers of switches, cables, CPEs, and now transmission equipment are becoming a significant force for change as their health depends upon increased investment in telecomns. The monopoly buyer's inability to purchase is leading to the sickness of these fledgling companies. They will influece the politicians to intervene. The waiters and those not provided with new services they need are together demanding that the nonperforming DOT be mended or alternatives to it be founed. And under the new liberalised economic and industrial policy, reliance for capital is to be placed not on taxes, direct or hidden but on savings of citizens through capital markets. Govt. can no longer borrow, burdened as it is with $ 80 billion and $ 130 billion external and internal debts respectively.

4.4 The Govt. has therefore decided that to begin with new services (like cellular radio and radio paging) should not be provided by govt. but by private companies only and that too on a competitive basis, from the beginning. But this policy has to be implemented by the DOT, the current operator, in its regulatory i.e licensing role. Here has come the unsurmountable difficulty. The DOT's civil servants whose careers are linked with service expansion by DOT itself, can not be psychologically prepared to let in rivals to themselves, to take away their business. Secondly, they had never been familiar as to what could be the criteria for choosing licencees. Thirdly, there is no policy as to what are the objectives of letting in private companies into the so far monopolistically provided,rather administered services- is it to promote competition, to reduce DOT's investment requirements, to enhance customers choice, or to get maximum rent from licencees to use it elsewhere, what are the terms of the inter-working in what respects (price,options,payment terms) could the private companies; compete; how would radio spectrum be alloted to contending claimants. In the absence of clarity of objectives and natural antagonism to the end of ones privileges, the process of awarding licenses is totally mired in irressolvable controversies and the bidders have gone to Law Courts on different counts and for different reliefs. In the event, the process begun two years (late 1991) ago has not resulted in the rolling out of service. This complexity and inability to implement liberalisation in telecom service area has brought the issue of independent regulator to the fore as all countries elsewhere in the world have placed in position precedent to liberalisation.

5. TENTATIVE MEASURES:

5.1 In the meanwhile, the investment crunch has revived another liberalising measure initiated about 5 yearrs ago but not implemented, again due to civil servants' reluctance to let go their monopoly power and no thought given to as to when a private enterprise will take up a particular business. High rise apartment buildings, business and market complexes requiring several hundred phones in a small area are coming up in cities. It was decided that private companies could put up PABXs which are available in plenty and with several features too, hire junctions to near-by public central offices and provide telephone services (much like the shared tenant services-STS-in the USA). But the commercial conditions attached were one-sided, simply extorting "revenue" from the licencees who would have to charge such high prices to users that none would take to that type of service. Currently, the thinking is to franchise or licence larger areas of a few square Kms to private companies to provide service by installing not only PABXs but main C.Os also. That would need DOT investing in trunking (junctions to tandem exchanges, and intercity toll circuits) . A number of private sector companies including foreign like the US-West have already been given "letters of intent" (LIs) by the D.O.T or have signed up Memoranda of Understanding (MOUs) with State Govt-owned Companies to approach the DOT for operating licences. Here again the commercial, interworking and settlement terms have not been thought through.

5.2 Yet another idea to increas the supply of services is to use the DOT's money not to buy equipment but to lease it as it would mean the availability of 2.5 times the equipment (assuming lease costs are 40% of purchase cost of equipment). But that recourse would militate against, not only demonmopolisation but also against, any restructuring of DOT's service provision functions into a corporation. That could be a tactic for short term relief against the chronic organisational disability.

5.3 Another measure being contemplated to attract private companies to invest in and provide telecom services in the rural areas is to give them choice of technology, ask no questions about source of capital into productive ventures, give tax holidays and exclusive franchiese for a few years. But here too the complexities of interconnection and internetwork payments are not worked out.

5.4 A number of new services (going by the name,value-added services) like E-Mail and store and forward FAX are already being offered by a number of mainly computer/ software firms, sometimes with the knolwedge of and licence from the DOT and as often without reference to it. We know that historically services were launched by the inventive and enterprising firms and their standardisation and regulation came later. The same phenomenon is visible in in telecoms in India just as in cable TV, where in less than 3 years,more than 10,000 operators have wired up 12 million homes and government is now grappling with the regulation of the Indian cable TV operations.

5.5 Taking cognisance of the technological developments, service needs, consumer rights, the urge for free enterprise and fresh funds, the Govt. has appointed a Committee to draft a new Telecom Law in replacemlent of the colonial times,(1885) privilege-securing and infromation exchange-restricting and subscriber-ignoring Indian Telegraph Act 1885 (The author is one of its Members). The Report was submitted in Oct.'92 but the coolness of the affected civil servants and the " business " of the legislators with other issues have so far ensured its inconsequence.

5.6 20% of the equity of the state-owned telecom enterprises, VSNL (which is the monopoly provider of all of India's international telecoms), MTNL (which provides local telephone,telex, radio-paging, services in two of India's largest cities Bombay and Delhi together accounting for about 28% of India's phones), I.T.I, HCL and HTL, the last three state-owned manufacturing companies had been dis-invested, i.e sold to financial institutions in 1992 They in turn, have sold them to the public, at huge profits. Current indications are that a further 29% (a total of 49%) of the equity may be disinvested in favor of the citizens. This disinvestment is the reason why the unions oppose Corporatisation of telecom, charging that the Govt.'s intention is privatisation by the sly and not aumentation of investible funds.

6. PROSPECT

It would thus be seen that in India we have the telecom Liberalisation process allready set in motion. The results of demonopolisation of production have been extremely beneficial to telecom users and the network owner also. It is with regard to network establishment and service provision that liberalisation is having difficulty, mainly beacuse the entrenched service provider, the DOT, a Govt. Department is the instrument to implement the policy. It is reluctant, apprehensive and unaware of the complexity and issues involved in the emergence and operation of competing but interconnecting networks. The country is handicapped in this regard because there has been no study of and inquiry into telecom matters by any intellectual body outside the DOT. The DOT's own Economic Research Unit is small and ill-equipped and inadequately patronised. There are no costing studies to know which facilities and services are costing how much; what are the cross-subsidies, which services are overpriced, by how much and which segments should be subected to competition under what conditions and to what extent. Finally the concept of an independent Regulator as has emerged in the USA, Canada, Australia, the European Community countries and even in developing countreis like Sri Lanka and Malaysia which have reformed their telecom regimes is yet to be crystallised and implemented as a precedent to any successful liberalisation. Trade and Commerce bodies, some Research and Study Institutes (the CTMS is one such) the Ministry of Finance (which is most concerned with liberalisation of the entire economy), Department of Electoncis, Financial Institutions and Banks (the largest users of telecoms), soft-ware companies (over 250) are all determinedly pursuing the cause and influencing the course of liberalisation, to be in tune with the global trend. The Govt. has placed (Aug.'93) at the head of the Telecom Commission, a non-engineer civil servant who is known for his liberalising and anti-monopolist fervour. The move by him to implement the 3-year old recommendation to convert DOT's service into several companies is being fiercely opposed and obstructed by the Unions and the top civil service engineers alike. Despite all this, it is confidently hoped that within two to three years, the Indian telecoms will be the most active and expanding sector to take the telephones to 20 to 30 million (availability of 2 to 3 per 100 people from the present 0.8) by the year 2000 and to 100 million by the year 2010, besides bestowing the country with every variety of telecom and information services as available in the developed countries.

Telecommunications in Venezuela: A Successful Road

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The Dynamics Generated in the Telecommunications Sector and the need of Venezuela to adjust to the same, have encouraged the state to promote a continuous process of restructuring of the sector pointed towards reaching the following objectives:

- Universal access to the telecommunications services at reasonable prices.
- Maximize the contribution of the sector to the Gross National Product.
- Make a major effort to develop the telecommunications basic network.
- Support the development of base industries (electronic and informatics).
- Stimulate the diversification of telecommunications services offered.
- Support the development of human resources of high quality.
- Convert Venezuela into an International hub of Telecommunications. Put Venezuela in an active position in the international organizations of the sector.

Due to the dynamic role of telecommunications in all areas of the economy, the state is seeking to maximize the contribution of the same for the benefit of the country, particularly in the development of its comparative advantages and to improve the standard of living of the Venezuelan people.

- Contribute to the internal integration of the country.
- Contribute to Venezuela's introduction to the world economy.
- Gear its potential contribution to the improvement of national productivity.
- Strengthen the process of decentralization and deconcentration of population.
- Create new technical disciplines and expand the existing in the country thus expanding the level of employment and improving the standard of living.
- Support the processes of investigation, technical development and industrialization, especially in electronics and informatics.
- Stimulate foreign investment. Contribute to the improvement of the services, such as, educational, public assistance in general, state and public security.

The intention is to create a highly advanced technical telecommunications sector to satisfy the needs of the country

- To incentive the digitalization from point to point and the integration of the services (voice, data and video).
- Satisfy demand due to mobility. Speed up incorporation of intelligent networks.
- Incorporate the signal transport sector on a very wide band to make better of the spectrum.
- Promote privately owned satellite systems.
- Use of the radio system to satisfy the demand of services.
- Incorporation of informatic services.
- Physical integration of the different operators networks (seamless networks).
- Bringing up to date the sector with latest technology.
- Technical modernization of the Basic Network of Telecommunications.

REGULATOR ENTITY

Planning and supervision of the sector entrusted to a regulatory organization conceived as an autonomous service without legal capacity.

- Highly professional with competitive salaries based on the labor market.

- Small and efficient organization.

- Dependent on private enterprise for supplying some regulated services.

- Geared to promote competition, develop the sector and protect the rights of the users.

- Transparency in all its acts.

PROSPECTIVES FOR THE TELCOMMUNICATIONS SYSTEMS IN VENEZUELA

- Promote competition in all the services.

- Guarantee the efficient use of the radio electric spectrum.

- Incorporation of a marketing mechanism **for assigning the** frequencies.

- Protection of the competition and rights of the user.
- Tariff structures that reflect true cost.

- A change at the very start from "competition wherever possible and regulation wherever necessary" to "maximum competition with a minimum of regulation".

PERSPECTIVES FOR THE TELECOMMUNICATIONS SYSTEMS IN VENEZUELA

Technology, new services, demand, competition and the strategic needs of the nation, forces us to prepare a flexible regulatory atmosphere with a look into the future.

OBJECTIVES:

TECHNOLOGY:

Incorporation of wireless telecommunications systems that make better use of the spectrum.

- Promoting the development of private satellite facilities. Conformity of interconnected seamless networks. Encourage development of wide Universal Broad band System.

SERVICES

- Satisfying completely the demands for basic services. Satisfying the demands for wireless communications, **data and** the different forms of audiovisual services.

Conatel will promote similar services to those offered in the more developed countries, backed by the latest advancement in technology.

The same will tend to satisfy the following needs:

- Integration of the services (voice video and data) by high speed transmission signals.

- Mobile communications (paging, data, trunking, PCS, determination by radio, aerial, maritime and land mobile).

- Informatics for all (software distribution, teleshopping, videotex, EDI, public directory, etc.).

- Video on demand, digital radio, HDTV.

Opening up the telecommunications services will substantially increase the existing source of employment and the figures shown give an idea of the challenge the educational system faces in the following years.

See Table Next Page

The opening up of this sector is well supported by various pillars, one of the most important of which is the demand for different types of services.

See Table Next Page

PERSPECTIVES FOR THE TELECOMMUNICATIONS SYSTEMS IN VENEZUELA

Technology offered worldwide shows important advancement which widens the offers for services and generates mayor stepwise economies.

ADVANTAGES:

- Integration on a greater scale of the most powerful and economic chips making it possible to increase efficiency of all the sub systems of the telecommunications networks.

- Greater transmission capacity by optical fiber and decreasing costs per kilometer (4 US $/16 km. fiber).

- Greater satellite systems capacity in transponders and greater power in radio links.

- Important advancements in software engineering which has made possible, among other things, the algorithm of video compression, increased intelligence of the networks and the reuse of the **frequencies in** the metropolitan areas.
- Increasing the capacity of digital links by microwave.

ESTIMATION OF JOBS

OPERATORS	1991	1992	1996	2000
Basic Network Telecommunications	21.100	20.500	24.000	30.000
Mobile Cellular Telephony	100	350	700	1.200
Private Networks of Telecommunications		1.000	5.000	10.200
Radio and TV	10.000	15.000	18.000	25.000
Others		1,000	6,000	9,000
DIRECT TOTAL	**31,200**	**37,850**	**53,700**	**75,400**

SERVICE	DEMAND FOR YEAR 2000	HYPOTHESIS FOR CALCULATION
Basic	4.800.000	20 % of total population
Cellular	840.000	3,5% of total population
Paging	600.000	5% of active population
Added Value	1.200.000	5% of active population
Data Networks	240.000	1% of active population
CT 2 and CT 3	240.000	2% of active population
Mobile Data	15.000	300 mayor companies of 500 workers and 5% the same users.
Trunking	360.000	3% of active population
PCS	240.000	2% of active population
Video Rental	1.500.000	25% of homes and 4% per home.

Note: The number of inhabitants is estimated at 24 millions for the year 2000 competition.

The EC's STAR Programme:
Lessons for the Pacific

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1. ABSTRACT

The European Community's STAR programme invested over $2 billion in advanced telecommunication in the EC's less developed regions. A recent evaluation yields a number of lessons of potential relevance to the Pacific Region.

1. INTRODUCTION: THE RELEVANCE OF STAR TO THE PACIFIC (1)

In requesting the submission of this paper, the PTC organising committee kindly enclosed a summary of the Missing Link Report (2), with a reminder that the theme for PTC'94 emphasises the links between this report, today's telecommunications environment, and progress over the next ten years. As my own copy of the Missing Link is, from use and abuse, falling apart, I requested a fresh copy from the ITU. This provoked the following response: "The Missing Link is now out of print and will not be reprinted."

Unfortunately, not only in the printed word but in reality also, *The Missing Link* is yet on the missing list: The gap between rich and poor countries in telecommunication access has grown the world over during the 1980s, with only a few pockets of exception (3). One hopes that this peculiar publishing lapse in not indicative of the ITU's attitude in general towards the problems of uneven access to telecommunications.

This is relevant to the subject of my paper, since what I will present are the lessons learned from one of the largest centrally-funded telecommunications programmes anywhere whose avowed aim was to narrow the gap both in infrastructure and services between rich and poor regions. The explicit goal was to aid regional convergence. I am referring to the EC's STAR Programme which, between 1987 and 1992 invested over $2 billion (4), half funded by the European Commission. While its relevance to the general topic of *The Missing Link* is thus clear, its application to the situation in the Pacific is open to question. Surely a quasi-federal state such as the European Community cannot be compared to the disparate and often divergent context of the Pacific? Even more, surely measures to address the relatively trivial differences between the rich and poor parts of one of the worlds richest regions, can offer few lessons to a region where disparities are ten and twenty fold greater?

Nevertheless, there also exist similarities and it is here that lessons may be applied:

- the greatly increased role of the World Bank, both in directly funding investment and in controlling its direction in telecommunication infrastructure, elevates it to a position somewhat analogous to that of the European Commission (5). The Maitland Commission itself, and continued by the ITU's BDT, also focused policy in a number of Pacific countries on bringing coherence to their telecommunication development initiatives (6); while the growth and concentration of Japanese bilateral aid programme in some regions may also encourage have the same tendency.

- Following on from this, but also related to the restructuring of telecommunication operators in many countries, there is a growing emphasis on funding coherent programmes incorporating a set of interrelated measures, and away from funding individual projects. Some of STAR's lessons are most pertinent here.

- There is some evidence that the focus during the 1980s on a narrowly defined market-driven approach to network and service development is insufficient, even for the long-term growth of a privatised operator. Rather, broader economic development goals must again (though now for different reasons) return to the agenda of national planners, multi-lateral funding bodies and telecoms operators (7). A narrow focus, for instance on investing only in the needs of major customers such as transnational corporations, is being questioned, and is not seen by some as contributing to the long-term growth of an indigenous sector and to strengthening the local and small economic units now regarded as essential to sustained and balanced growth.

- At a national level, rapid growth in a few countries of Asia and the Pacific

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has thrust some of their regions well ahead of others, and here telecommunication development programmes may be considered as a means to redress the balance.

In sum, their is a growing role for certain agencies in the Pacific in telecommunication development; a continuing trend towards coherent programmes rather than individual is underway; and evidence of a movement back towards the need to address the Pacific region's territorial and sectoral disparities in the interests of overall sustained growth. Economic disparities *within* rapidly growing countries are also a cause for concern, and regional development programme may comprise an aspect of the solution. For all these reasons the future experience of investment in the Pacific is likely to begin to look a little more like the STAR Programme than it has in the past, and this may be true of the national level as well of the level of the region as a whole.

2. BASIC FEATURES OF THE STAR PROGRAMME

The STAR Programme was agreed jointly by the Directorate General for Regional Policy (DGXVI) and the Directorate General for Telecommunications, Information Industries and Innovation (DGXIII), and approved by European Community member states in 1986 (8). In the context of a major plan to liberalise telecommunications in the EC dovetailing with the thrust to the internal market by 1992, it was conceived as a way to strengthen peripheral and weaker member states and regions in the more commercial international telecommunication environment of the future. In the mid 1980s differences between member states in terms of penetration of telephony varied considerably, ranging about from about 20 lines for 100 population up to about 50, and at an EC sub-national level variations were greater still.

The importance attached to telecommunication services is indicated by the fact that this was the first of a new kind of EC programme, one where the Commission itself rather than member states took the initiative. It is also reflected in the funding provided: over $990 million (9) of the Commission's own funds were invested between 1987 and 1992, and this was more than matched by funds from the member states themselves bringing the total to over $2 billion.

About three quarters of this was spent on improving the network infrastructure. Although the programme focused on advanced telecommunications, this was defined widely enough to include digitalisation of the network, which these days is perhaps more properly regarded as a basic requirement for an efficient network. The remainder was spent on a whole range of advanced services, from videotext to local teleservice centres, and it included even funding for user terminal equipment.

Based on the guidelines provided in the STAR Regulation (which came to all of 5 pages), each of the seven EC member states (10) submitted a national intervention plan to the Commission indicating measures they proposed for funding. After some (mostly minor) haggling, the Commission approved them, retaining for itself a relatively minor role in their implementation and monitoring. Indeed, the Regulation conceded so little power to the Commission, that at one point there was some doubt as to whether an evaluation could be completed at all.

This decentralised approach to STAR lent it one of its hallmarks: a great diversity at national level in terms both of programme implementation and management and of the measures supported. It also contributed, unwittingly, to the richness of the lessons obtained. In total, hundreds of network projects and thousands of service application projects were completed—and diversity was also maintained with regard to their impact. Although time alone will deliver the final verdict, especially for the application service providers, the innovative nature of the programme yielded successes and failures in sufficient numbers and variety to keep the telematics research community busy for years to come.

3. LESSONS FROM THE PROGRAMME

Our evaluation, for more than just political reasons, was concerned more with gathering examples of good and bad practice than it was with 'finger-wagging' at member states and projects that made mistakes—and there were certainly more of the latter than could be explained entirely by the innovative and hence risky nature of the endeavor. Examples of good and bad practice came at several different levels of the programme, some of more relevance here than others.

Below, five relatively high level and abstract lessons are presented, selected for their general applicability in other regions and to the Pacific in particular.

Lesson 1. In programme investment proposals, treat with scepticism any claims to directly relate investment in network infrastructure to economic growth.

Much work was done during the 1980s exploring the link between telecommunications network investment and economic development, especially by the ITU and World Bank (11). However, it is still as difficult to trace clearly, *ex ante* or *ex post*, a causal link between telecommunication investment and economic growth. This is just as true in a programme explicitly devoted to economic development ends, as it is in one more conventionally profit driven. There are simply too many independent variables intervening between the investment and the final impact.

The STAR Programme preparatory studies, and indeed the evaluation, attempted this. But a large number of often tenuous linkages had to be established. How many users were there for different services, currently and in the future? In what manner, and to what extent would telecommunications increase efficiency in different sectors and different stages of the production process? How would increased efficiency impinge on employment and qualification issues? And how would all these in turn affect to economic growth and development? Further complicating factors include the extent to which the presence of advanced services attracts new employment from other areas, simply consolidates jobs that would otherwise disappear or actually creates new ones. Perhaps advanced services even contribute to a 'paradigm shift' that changes fundamentally the relationship between suppliers, manufacturers and customers such that a whole new wave of deep reverberations is set off in the economy with unknown final impact. Throughout all areas, the difficulty of distinguishing the influence of telecommunication services from all other factors also proves a formidable obstacle.

Even where precise quantitative knowledge is available to illuminate certain parts of the overall picture, too many will always remain clowded in uncertainty to derive the kind of causal relationships so valued by policy makers. And the nature of the problem is such that one missing link alone is enough to compromise the validity of the entire logical chain.

Thus planning investment in advanced communications aimed at a region's economic growth (rather than for instance maximising short-term revenue and profits for the operators and service providers) must take a form other than traditional project cost/benefit analysis.

So what should that form be?

Lesson 2: For network infrastructure investment, evidence of direct causal links to regional development are not always essential.

The fact that infrastructure improvement can impact on a huge range of sectors and users is an obstacle to determining the precise avenues of influence. But it is also one of its assets: what studies *can* show with reasonable certainty is that *the lack of good-quality infrastructure will retard economic development in a myriad of small ways that together add up to something of significance.* In the EC as elsewhere, the relative backwardness in a given country of network infrastructure as compared to both other infrastructures and general economic indicators, is a significant impediment to development and can constitute a bottleneck to economic growth at all levels. While it is acknowledged that there are always competing demands on resources, an evident network deficit relative to countries that are in other respects comparable constitutes in itself strong grounds for an investment programme.

The second criterion is simply the narrow one of commercial rate of return: in countries where a certain threshold of development has been reached, a survey undertaken as part of the STAR evaluation found a relatively high rate of return for telecommunication network investment. It was also the case in peripheral EC countries that there was insufficient investment capital available to take up many highly profitable investment possibilities, so that the marginal projects funded under the Programme achieved high rates of return. Conventional rate-of-return analysis based on estimates of cost and tariffs is thus important.

Of course, what the narrow approach fails to reveal is where return on investment and the needs of economic growth diverge. Translating the regional development aims of the STAR programme into the context of the Pacific would suggest that achieving the greatest user penetration and the greatest geographical scope, would be essential features of any programme aimed at broader economic development. This was argued implicitly by the Maitland Commission and other ITU studies tend to back it up. One way of achieving this is by extending networks and services to non-metropolitan, even rural, areas, and focussing on the needs of medium sized and small industries rather than solely on those of large firms.

But here, where regional or sectoral goals come to the fore, the general arguments for investment in telecommunication investment are insufficient. In other words, evidence of a relatively poor level of infrastructure, combined with a good anticipated rate of rate on the projects proposed for funding, will catch some of the regional development objectives. But capturing the benefits from indigenous and small scale development might require more specific targeting.

Before considering how this might be done, a final point should be added. In a co-funded project (where some funds are provided from an international source and the rest nationally), complementarity of aims can also be an important criterion i.e. investment is more effective where there is already a high priority given nationally to the sector's development and this is expressed through a strong investment programme. It might seem that a funding agency should direct investment towards where it believes national interest is too low. In reality, however, a greater impact and increased complementary funding is likely to be achieved where investment is aimed at further boosting an already high national commitment. (For STAR, a problem was that regions with less than wholehearted commitment to network development in effect found ways of switching EC telecommunications aid elsewhere, by funding projects that would have gone ahead anyhow.)

Lesson 3: Network development programmes aimed at indigenous industry and regional goals, as well as programmes that promote advanced non-network services, must clearly establish strategic links between the means (applications and value-added services) and the end (regional economic development).

We have claimed above that in many situations, it is not essential to justify network investment in terms of expected and quantifiable economic impact along determined and visible avenues. Rather, general considerations coupled with narrow economic return criteria are sufficient. We also pointed to limitations: where there are more focused development aims that fall outside commercially determined goals, such as nurturing indigenous or small industry, then something more is needed.

The same is true for service applications, that is, services developed by third parties offered to users over the telecommunication network. Most of these services are very user and sector specific, and, like the broader development goals, they therefore demand careful targeting and planning.

In the STAR Programme, member state intervention programmes outlined the regional economic goals to be addressed, and presented the measures proposed to achieve them. Most contained well-worn statements concerning the ability of telecommunication to reduce the penalty of peripherality, the supposed link between economic development and the level of telecommunication infrastructure, and so forth. However, the set of measures proposed, and *a fortiori*, the measures actually implemented, bore no specific relationship to the rationale offered for them. The underlying thought behind the programmes could not be reconstructed from an examination of the measures actually supported, in any member state.

There was thus a yawning conceptual gap between general aspirations and the actual measures proposed in national programmes. Goals were lined up at the beginning of the document, measures proposed at the end, and between them was a distinct absence of substantive ideas. Given the time constraints and the limited resources available to the European Commission to evaluate such programmes, it goes without saying that such obvious gaps did little to inhibit funding. They were approved with only minor adjustments.

What was lacking was a strategic vision of how advanced telecommunications can intervene in the development process. There are several basic steps involved in establishing an integral link between the two, such that a consistent thread of logic can be extended from relatively abstract regional goals to actual programme measures and actions. A clear understanding is required of:

- the most effective *intervention targets*, in terms of for instance economic sector and types of localities: Which sectors will make most effective use of such services? Which types of localities and 'milieu' of firms should be supported? How in practice the 'information environment' of a region is related to economic growth? and so forth;

- the most effective *intervention mechanisms*, that would maximise the impact of subventions on the growth of the appropriate services in the interests of economic development. For instance the merits of terminal distribution as distinct from service development support; whether closed groups of users should be supported as distinct from services to be made available publicly; the ultimate potential impact of EDI as compared to databases; and so forth. Here the aim is to optimise the impact of subvention by not substituting for what might be achieved in its absence, by purely commercial means or market mechanisms. It is thus a question of intervening at those bottlenecks where market and other mechanisms fail.

- how the *economics of specific advanced services* can be harnessed to enhance their growth and viability. For instance the need for a critical mass in some services; the effects of rapid changes in technologies, and the current and likely trends; the number of users in relation to cost that different types of databases typically require; the relationship between usage and timeliness of data in databases; tariff policies in videoconferencing; critical mass in e-mail in relation to different types of communication communities; costs and advantages of different methods of billing; the desirability of integrated delivery for a variety of services; and so forth.

These are the three steps in a programme: targeting the right intervention areas; selecting appropriate intervention mechanisms; and tailoring these to the economics of advanced services. Without them, an intervention programme is essentially reduced to a work of fiction.

FIGURE 1: STEPS IN STRATEGY DEVELOPMENT

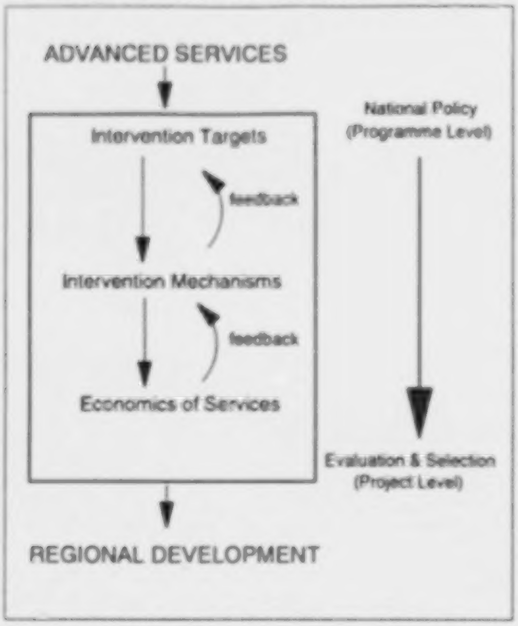

Figure 1 also illustrates the need for a feedback process when devising the strategy, since optimal negotiation of each of the steps will depend on the selection of the other two. Also depicted is the fact that devising a strategy moves from programme level issues relating to national policy objectives down towards project level issues relating to the economics of specific services: this underlines the need to combine specialist expertise in regional policy development, in advanced services for users and in business development; and, at the level of developing national programmes, an intimate knowledge of the region's resources and of the legal and administrative environment in which the programme will be implemented.

Lesson 4: Do not underestimate the deceptive nature of 'Latent Demand': uncover real user needs

Perhaps a degree of leniency is due to harassed officials frantically responding to externally imposed deadlines for strategy development and submission. Indeed, perhaps, it is asking too much to expect well-thought out, coherent, strategies in areas of technology and development that are as yet ill-understood and largely untested.

In fact, even the best laid strategy will achieve no more than allow programme developers to target the right sectors and services, and to know what kinds of projects they should be seeking. The next stage is to instigate a process that will elicit such projects from potential promoters in the public or private sectors. And at this point, they face a fundamental challenge deriving from funding projects that are not responding to an expressed market demand: how can we be reasonably sure that the services developed address real needs?

Normally, demand works through *self-selection*, that is, a firm independently chooses to purchase an available service at a given price. In this case, conventional market research is sufficient to determine, at least broadly, which services might be in greater demand and how much revenue they might yield. Users have a good idea of the utility of the service, and hence what they might be willing to pay.

However, advanced telecommunication services in less developed regions exist to a large extent in the context not of *expressed demand* but of *latent demand*: that is, demand for services the implementation of which would (possibly) benefit users, but the potential of which, for various reasons, goes unrecognised by would-be users. This is because the user has nothing to compare the services against and finds it difficult to discern what the impact might be, especially where it involves procedural or other work-organisational changes.

Yet the concept of *latent demand* is a trap for the unwary programme promoter, and an opportunity to the unscrupulous project promoter. The very existence of latent demand may be no more than a figment of the promoter's imagination, since by definition, evidence for it is indirect. This poses the very real danger that all kinds of advanced technical solutions will be proposed for problems that simply do not exist-a technocrat's heaven.

However, assuming for a moment that such demand does actually exist in unexpressed form, the crux of the problem is: users refuse to try out services until they are convinced of the benefits, but they cannot discover the benefits until they try them out.

The lesson here is to tailor a strategy on the basis of an understanding of this issue. Where demand is just at the point of expression (where firms are, for instance, already well involved in computing technology), then the strategy adopted will veer towards offering a range of services at the right price: the market can sort out the winners and losers amongst them. Where there is more hidden resistance to usage, then greater intervention in the form of intensive promotion, training and support are required.

In either case, two factors are essential to ensuring the relevance of services developed. First, users should be directly involved in services development. Second, there is no substitute for in depth micro-level analysis of user needs undertaken on the premises of potential users. In contrast to conventional market surveys, these reach beyond needs immediately perceived by management, and bring to light the *processes at work in user organisations* and hence also potential or latent needs.

Lesson 5: Support, and learn from, programme innovation

The final lesson refers to learning.

The STAR Programme set out to introduce into less developed regions of the EC services that, in many cases, were yet to be proven in developed regions. This is quite different to more conventional infrastructure and services programmes, such as roads, rail, and basic telephony. The aim was less to catch up with advanced regions, than to give some kind of head start, or indeed to break new ground in development trajectories that were specifically suited to less developed regions. Thus learning processes (some more successfully than others!) were at work in both programme conception and implementation.

At project level there was institutional, or 'social', innovation. In EDI, service centres and database use, for instance, it was a case of establishing new forms of working relationships between service providers and firms, between firms and clients and subcontractors. Here, old habits were to be broken and new practices experimented with, both for service providers and users. Service providers had few role models and virtually no competitors from whom they could take their lead.

Innovation among users was also clearly necessary. Devising ways to extract maximum benefit from the new technologies often demanded organisational change. In many cases the adoption of advanced telecommunication services at the same time demands the introduction of other complementary technology such as information technology.

Finally, it is worth noting that innovation at all levels of a programme requires flexibility in objectives and implementation strategies-itself an innovative move. For such a programme to function effectively, new communication links must be established between programme management, service suppliers and users, creating a 'feedback loop' that facilitates the evolution of the programme within a shifting environment. Horizontal learning mechanisms, between different programme managers in a multi-national programme, and between projects, must also be put in place.

In general the STAR programme did not fully recognise, and hence capitalise on, the extent and nature of its innovativeness. Insufficient effort was devoted to ensuring that: (i) support was available to deal with innovation; (ii) lessons for current projects and future programmes were learned, documented and applied. The effectiveness of the projects was thereby, perhaps marginally, reduced. More important, however, was the failure to appreciate the value of STAR as a 'social experiment', that is, not simply as a programme to promote the use of advanced services but also as a vast controlled experiment in new ways of doing things, of learning how innovation is dealt with in different areas, and of how it can be fostered and supported. The research, data gathering and analysis mechanisms were never considered at programme conception.

Perhaps as a researcher I tend to overvalue these elements, but there is no doubt that many lessons were lost as a result that would have been valuable in the design of future programmes.

4. CONCLUDING COMMENTS

These lessons can be summarised in a number of propositions:

- the nature of infrastructure's contribute to the economy is such that mapping the precise impact and benefits from empirical data is always going to be well-nigh impossible, before or indeed after the investment. But this need not be a problem where the effects desired are general to a wider economy: investment can be justified through a needs determination and cost-benefit analysis.
- The more one wishes to focus the investment, on specific types of firms or sectors or on specific advanced non-network services, then a high level of strategic understanding is required of: where to intervene, with what to intervene, and how to intervene.
- Even then, any non-market based investment programme must find ways to relate closely to real user needs, especially where services developed are unfamiliar to users.
- Programmes demanding a high level of innovation must allow both for internal learning processes and for recording and disseminating lessons.

While maintaining the general applicability of these to contexts beyond the EC, there is of course no blueprint for successful implementation. While we can certainly learn from mistakes and successes, if nothing else, the experience of STAR has taught us that the main input for designing and implementing any programme must come from the specificity of the needs of the regions being considered.

But a prior question is whether those needs are best served at all by a centralised, grant-aiding, programme such as STAR. At the outset I alluded to certain factors that might increase the relevance of programmes such as STAR in Asia and the Pacific region. This paper was critical, sometimes harshly, of STAR (I am, I hope, far enough away from the EC here to make these claims with impunity) but I hasten to add the STAR Programme came through the evaluation with quite a clean bill of health. It was judged to be a good investment (indeed, there would be little point to retaining the lessons if the core exercise itself were worthless). While it does not follow that the Pacific might also benefit from this type of programme, it does suggest that it merits some consideration.

1. The author was Deputy Leader of the final evaluation of the EC's STAR programme. The views expressed here are his own, and not necessarily those of the whole team.
2. *The Missing Link: Report of the Independent Commission for World-Wide Telecommunications Development*, ITU, Geneva, December 1984.
3. For an overview of issues see: Seán O Siochrú, Global Sustainability, *Telecommunications and Science and Technology Policy*, Commission of the European Communities (MONITOR/FAST Global Perspectives 2010: Vol 14, FOP 329), Brussels, 1993.
4. 1.55 billion European currency units (ecu) were invested in total. The rate of exchange with the dollar varies considerably. An average $1.3 per ecu is used here for convenience.
5. George A. Codding, 'Financing Development Assistance in the ITU', *Telecommunications Policy,* March, 1989. See also: Gerald Sussman, 'Telecommunications for Transnational Integration: The World Bank and the Philippines' in Sussman and Lent 1991.
6. Jussawalla, Meheroo and Michael R. Ogden, 'The Pacific Islands: Policy Options for Telecommunications Investment', *Telecommunications Policy,* Vol 13, No1. March 1989.
7. See for instance Sussman, Gerald and John Lent (eds), *Transnational Communications: Wiring the Third World,* Sage, London, 1991.
8. Council Regulation 27th October 1986.
9. 761 million ecu.
10. Eligible were all of Ireland, Portugal and Greece, most of Spain, and parts of Italy, the UK and France.
11. For instance: Saunders, R., J. Warford and B. Wellenius, *Telecommunications and Economic Development*, World Bank, 1983; ITU, *Telecommunications for Development*, Geneva, 1983; and ITU, *Information, Telecommunication and Development,* Geneva, 1986.

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THE ITU, REGIONAL STANDARDIZATION AND DEVELOPING COUNTRIES' CONCERN

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1. ABSTRACT

Beside the International Telecommunication Union (ITU) in the world standardization scene, there are some regional organizations. These Regional Standardization Organizations (RSOs) cause some complexities of choices specially for developing countries. This paper outlines some major RSOs, the development of ITU and developing countries' concern in the standardization.

2. INTRODUCTION

There had been at least two crucial problems facing the international role of ITU (International Telecommunication Union) in standardization. First, the standardization process was too slow, a four year cycle, in this era of fast technology development. Second, ITU with more than 160 member countries, is a very 'heterogeneous' institution. It is sometimes very difficult to reach agreements. These problems have led to dissatisfaction in some developed countries who want their standards to be recognized by the ITU. As a result, some regional-standardization bodies emerge from the USA, Japan and Europe.

The major Regional Standardization Organizations (RSOs) are the ECSA (Exchange Carriers Standards Association) in the USA, the TTC (Telecommunications Technology Committee) in Japan and the ETSI (European Telecommunications Standards Institute) in Europe. There is a tendency that RSOs harmonize their works outside the ITU meetings. A meeting in Fredericksburg (Besen, 1991, p.36) is an example. This is a serious threat to the ITU.

Richard Butler (1990, p.21), the former Secretary General of ITU, said that RSOs 'have adopted more aggressive disciplined and project oriented methods and with their industry and user driven outlook they have the capacity to produce results more quickly.' There is a critical choice for policy makers to have *'global standards'* or a *'variety of regional standards.'*

In fact, those countries in the RSOs are also members of the ITU. They could agree before the meetings of ITU standards-making organ, CCITT (International Telegraph and Telephone Consultative Committee) and CCIR (International Radio Consultative Committee) [CCITT and CCIR after Additional Plenipotentiary Conference in December 1992 is 'merged' and called as Telecommunication Standardization Sector (TSS)]. Therefore it is possible that ITU becomes a 'rubber-stamp' institution (Besen, 1991, p.312)

The paper discusses the standardization problem because of the RSOs, the restructuring of ITU and developing countries' concern. The author argues that the future global telecommunications network will be sufficiently complex to allow national and regional differences.

3. THE STANDARDIZATION IN THE ITU BEFORE 1993

A standard, from its nature, is an international agreement. In telecommunications, equipment must be developed with international standards if they are to be sold world-wide. This is a necessity from a technical or economic point of view (Economic Commission for Europe, 1987, p. 43).

The ITU has been successful in setting the standards. It can be seen today that everyone can telephone to anywhere in the world. It is difficult to imagine how such a network will exist without an international agreement. In 1848, Prussia had to sign 15 conventions to construct the line in its territories (Corner, 1990, p.19). Now the ITU conventions replace such agreements.

Standardization requires a very high effort. The TSS director Th. Irmer gives an example: 6,300 pages (A4 format) had been produced at the end of the 1976-1980 study period; at the end of the consecutive period (1980-1984), this number had dramatically increased to 11,600 pages (Economic Commission for Europe, 1987, p.46). The reason, Irmer added, is that the fast development of technology needs not only broadening (more elements to be standardized) but also deepening (more to be standardized).

The ITU standardization methods, specially before 1993, caused problems, namely, such standards can only be endorsed after a four year cycle in the Plenary Assembly. This is unacceptable in the era of rapid technology development (Corner, 1990, p. 20). Moreover, CCITT has to offer many 'options' in its standards to reach agreements (Besen, 1990, p. 527). As a result, some equipment might comply with ITU standards but not be compatible. In other words, machines cannot communicate to each other unless some modifications are made.

The slow work of ITU has pushed some leading developed countries to produce their own standards more quickly. These standards by Regional Standardization Organizations (RSOs) - backed by leading manufacturers- will then be examined by ITU standardization bodies. It is unlikely that ITU will reject such proposals (Besen, 1991, p.320). The 'rest of the world', mainly less developed countries (but also countries that are developed but weak in manufacturing, e.g., Australia) have to accept such a scenario (Corner, 1990, p.20). Is ITU slowly becoming a 'rubber-stamp' institution ?

4. THE REGIONAL STANDARDIZATION ORGANIZATIONS (RSOs)

In general, RSOs produce their standards more quickly and more efficiently. There are some characteristics of RSOs. First, RSOs are 'homogenous.' The USA (ECSA) is one country, as well as Japan (TTC). The ETSI was set up for the 1992 Europe single market. Second, in contrast with ITU, RSOs can reach the agreement by voting. Those RSOs will be outlined in the following paragraphs.

4.1 The Exchange Carriers Standards Association (ECSA)

After the divestiture in 1984, AT&T cannot set the domestic standards any longer. Therefore, the ECSA was formed. In this association, the T1 committee is responsible for standardization work. The committee consists of local exchange carriers, including the seven Regional Bell Operating Companies (RBOCs), interexchange carriers and equipment manufacturers (Besen, 1991, p.314).

Unlike the ITU, ECSA T1 uses a voting procedure if a consensus is not possible. Two-thirds of those voting is a must for a standardization approval (Besen, 1991, p. 314).

4.2 The Telecommunication Technology Committee (TTC)

For the same reason as in the USA, NTT in Japan must give its authority in creating 'de facto' standards to another organization. This body is the Telecommunications Technology Committee (TTC). The TTC, formed in 1985, is a private standards organization. The membership comes from carriers, manufacturers, and also foreign entities (Besen, 1991, p. 314).

The TTC has also practiced voting procedure to reach agreements. In comparison with T1 and ETSI, Besen (1991, p.315) stated that the TTC is a 'strict' standards organization. That means, the TTC standards are based on ITU standards but all the options are filled with Japanese 'profiles.' Some analysts say that the TTC is a 'downstream' standards organization whereby the T1 and ETSI are 'upstream' (propose to the ITU bodies for new standards).

4.3 The European Telecommunications Standards Institute (ETSI)

The ETSI is an interesting organization. With the intention to unify the fragmented European market, the ETSI was set up in 1988. The goal is to harmonize European networks with standards-compatibility (Besen, 1991, p. 315). This allows the European manufacturers to operate in a 'single European-standard,' and guarantees that their equipment can communicate to each other's without modifications.

The ETSI permits a wide membership (in contrast with the former ITU which is formally a group of telecommunications authorities) : network operators, users, private service providers, manufacturers and research bodies. The voting procedure is also applied. To speed up standardization, the ETSI in some cases uses a 'project team' approach. The project team, appointed by the Director of ETSI, is assigned to develop the standards. Of course, this method is faster, however Besen (1991, p. 315) argues that those standards may have difficulties in adoption.

5. DEVELOPING COUNTRIES' CONCERN

The developing countries' position is very important to mention because of their equipment purchasing from RSOs member countries. Indeed, Neu (1989) stated that developing countries still have the largest import share of telecommunications equipment:

Telecommunications Equipment Imports in World Trade 1985

United States	= 24 %
Japan	= 0.7 %
Europe	= 24.5 %
Developing Countries	= 30.4 %
Others	= 20.4 %

Source: Neu (1989)

Furthermore, developing countries 'permits the use of telecommunications equipment only if it meets ITU standards' (Besen, 1991, p. 320). The confirmation of the ITU is very important, if those RSOs member countries would like to sell equipment to developing countries. In this situation, RSOs maintain their 'low-profile' behavior towards the ITU by saying that their works are always in conjunction with ITU standardization and acknowledging that ITU is the 'supreme' standardization body.

6. THE ITU CHANGES

ITU is not silent about the emerging of RSOs. The first attempt to reduce time in standardization occurred at the CCITT Plenary Assembly in Melbourne, 1988. With the approval of ITU Plenipotentiary conference in Nice, 1989, ITU now have adopted an accelerated standards-making procedure for some cases (Codding, 1990, p. 355). The procedure is to send proposals to member countries. Within 3 months, if 70 % have answered 'yes', then the proposals become officials standards. This procedure can reduce time from four years to only nine months (Codding, 1990, p. 355). However, Besen (1991, p.320) argues that the ITU still could not outpace RSOs because of its large and diverse membership.

Another important measure is the structural reforms recommended by the High Level Committee set up by ITU Plenipotentiary Conference 1989 - The supreme organ of ITU -. The recommendation is put into force after the Additional Plenipotentiary Conference in December 1992 in Geneva. The ITU is now organized in three activities: Telecommunication Standardization Sector (TSS) as a 'merger' of CCITT and CCIR because of many overlapping, Radiocommunication Sector (the former IFRB and some CCIR works) and Development Sector (through a new Telecommunications Development Bureau to assist developing countries).

The High Level Committee reports that 'ITU should play a stronger and catalytic role in stimulating and coordinating cooperation between increasing number of bodies concerned with telecommunications' (Codding, 1991, p. 269). This is a new role and new position of ITU to be existed in today's environment.

It is clear that ITU has recognized the threat from other standardization bodies by setting up a High Level Committee and an Additional Plenipotentiary Conference. It seems that ITU has a good compromise to accommodate the needs of RSOs and developing countries. Otherwise, a similar problem such as the USA withdrawal from UNESCO in the 1980s will probably happen again (Jonscher, 1984, p. 2). The situation is up to the RSOs to use TSS conferences as a negotiation forum. The fact is, however, RSOs have a stronger position than the others.

7. CONCLUSION

The 'triad' trading blocks have their shape in the ITU standardization. Those blocks are ECSA T1, TTC and ETSI. It is a serious and difficult problem for ITU. On the first hand, ITU should maintain its function as a 'supreme' standardization and regulation body in telecommunications. On the other hand, ITU has to accommodate the needs of developing countries for assistance and the impatient Regional Standardization Organizations.

The ITU perhaps will play an important role as a 'catalyst" in the future as the High Level Committee of the ITU suggested. This does not mean that ITU will be a 'rubber stamp' institution. However, the deliberations will be different and much be influenced not only by technical or economical constrains but also by political issues. So, the future global telecommunications network will be sufficiently complex to allow national and regional differences.

At the end of the day, however, ITU is still important as telecommunications is a global infrastructure. No other organization has such a large member as ITU. It is up to RSOs to compromise in the ITU conferences. Otherwise, we have non-international-standards and incompatible equipment.

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CHANGES IN TELECOMMUNICATIONS REGULATORY STRUCTURE & GUIDELINES FOR FOREIGN INVESTORS IN THE SOCIALIST REPUBLIC OF VIETNAM

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ABSTRACT

The paper discusses the new telecommunications infrastructure which was introduced in July, 1993. The new infrastructure would allow for partial or full privatisation of the Operator and allows for a Government Regulator to oversee the telecommunications development.

In addition the paper gives an overview of investment issues and intellectual property issues in Vietnam.

1. COUNTRY PROFILE

The area of Vietnam is 3,290,707 square kilometres of which about 20% is used for agricultural purposes, 31% is dense tropical forest and about 15% is vast rolling plains. See Figure 1.

The southern region includes the mineral rich basalt covered Mekong River Delta, the country's traditional main rice bowl. Areas north and south of HoChiMinh City are rich, largely unexploited tropical and mangrove forests. Large hilly and mountainous plains and forests cover about half the northern part of the country. This upper region includes the economically important Red River Delta. Rice growing provinces in the north are disaster prone areas sustaining heavy damage brought by extensive annual monsoon flooding. Vietnam has abundant natural resources including phosphate, coal, manganese, bauxite, chromium ore, offshore petroleum, rich forests, rubber and marine products.

1.1 POPULATION

The population in Vietnam in 1991 was officially 70.2 million with an estimated annual growth rate of 2.13%. It's population is projected to rise to 88.3 million by the year 2000. Of this national population, the most recent census showed that 20% of the Vietnamese lived in urban areas and 45% of the total belong to the under 15 age group. The census also indicated the composition of the Vietnamese population was 90% Vietnamese and 10% ethnic minority groups including about 1.2 million Chinese. The economically influential Chinese mostly settled in southern Vietnam where they concentrated on the rice trade, operated rice and timber mills and other factories. They are also engaged in real estate business and run private credit co-operatives in the south.

1.2 EDUCATION/SKILLED LABOUR

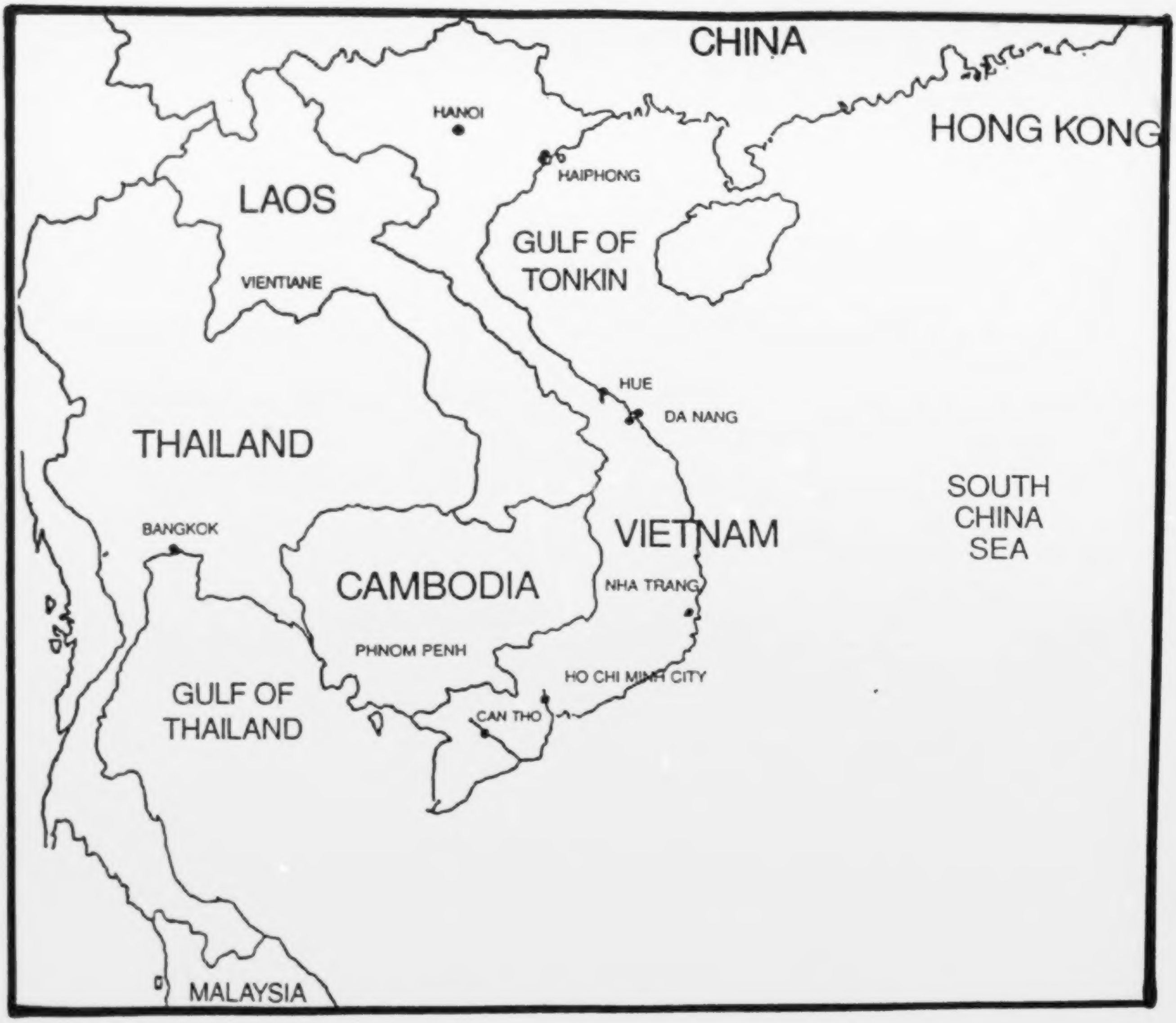
In 1991, 12 million Vietnamese children attended primary schools, another 934,000 were enrolled in secondary schools and 152,000 went to institutions of higher learning. The national literary rate in 1989 was a high 82%.

2. TELECOMMUNICATIONS INFRASTRUCTURE

Regulatory Structure

The Vietnamese Government and, in particular, Premier Vo Van Kiet recognise that development of key telecommunications infrastructure is a matter of high priority both as a facilitator of commercial activity and an important part of the social, political and welfare development of the country. The Government and the Director-General of Posts and Telecommunications are also aware of the significance of being in control of the telecommunications infrastructure and in particular, of the level of funding likely to be introduced and the potential levels of cash flow and profits likely to be involved in the long-term. This has led to a fairly lengthy policy assessment and and the process of reorganisation and repositioning of key responsibilities and positions. An additional complicating factor in the attempt to finalise allocation of regulatory and operating rights and responsibilities has been the differences of approach between the Regional Directors and the Central Administrators in Hanoi. This has been particularly obvious in the case of HoChiMinh City which has a strong local business culture and which is enjoying growth rates far greater than those being experienced elsewhere in the country.

Prior to 1990, the Director-General of Posts and Telecommunications (DGPT) was responsible for both the regulatory and the operational aspects of Posts and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GULF OF TONKIN
VIENTIANE
HUE
DA NANG
THAILAND
SOUTH CHINA SEA
BANGKOK
VIETNAM
CAMBODIA
NHA TRANG
PHNOM PENH
HO CHI MINH CITY
GULF OF THAILAND
CAN THO
MALAYSIA

Figure 1

Telecommunications. In 1990 the Government established a Ministry of Transport and Communication within which was established a Department of Posts and Telecommunications. That Department had responsibility for regulatory and policy matters for both posts and telecommunications. The DGPT was the operational entity and reported to the Department of Posts & Telecommunications. In October, 1992 the Government decided to separate communications and transport. The Ministry of Transport now deals only with transport matters. The DGPT re-established it's responsibility for both the regulatory and operational sides of posts and telecommunications. In July, 1993 the DGPT was itself split into the Secretary-General of the Department of Posts & Telecommunications (DGPT) responsible for policy and regulation and Vietnam Posts and Telecommunications (VNPT) which is the operational arm. See Figure 2. The VNPT includes Vietnam Telecom International (VTI) responsible for international lines, Vietnam Telecom National (VTN) responsible for the national trunk network, Vietnam Postal Services (VPS) and Vietnam Data (VDC). The DGPT also maintains and operates broadcasting facilities on behalf of the national broadcaster.

The Secretary-General of the DGPT reports directly to the Prime Minister and has the status of a Minister. The Prime Minister also has a small group of independent advisors on matters relating to posts and telecommunications. It appears likely that the structure now in place will continue at least until 1995. At that time it is likely that the VNPT will be partially or fully privatised. 1995 is the expected date that the Hanoi Stock Exchange will commence operation and VNPT may be one of the first Government organisations to be privatised.

The Prime Minister's office has expressed a desire for the rapid introduction of new, more modern and comprehensive posts and telecommunications laws. It is likely that the new legislation and regulations will consolidate the existing position until 1995 and then allow more suppliers of services, and perhaps infrastructure, to enter the market.

2.1 Operating Structure

As stated above the carrier in Vietnam is now the VNPT. It's main operating arms are:

(1) Regional Operators (The Local Loop);

The local line links are the responsibility of the local Directors of Posts and Telecommunications of which there are 53, one in each region of Vietnam. The two most important regions are Hanoi and HoChiMinh City.

The Regional Directors are responsible for both telecommunications and posts and a number of other functions. Building and facilities are shared between the two operations. Although there are supposedly regulations as to what type of equipment may be connected to the network, Regional Directors appear to be given some discretion as to what equipment may be installed and used on the PSTN and what equipment can be supplied as CE. However guidelines as regards approval must be authorised by Hanoi.

There is at this stage, little notice to standards of interconnect between different manufacturers equipment. The problem would appear to be that Vietnam will take any equipment as a gift from those countries prepared to grant money to their respective organisations for supply of equipment. The Regional Directors, particularly in HoChiMinh City, appear to exercise some autonomy as to the introduction of new services for example mobile and paging.

(2) Main Trunk Routes

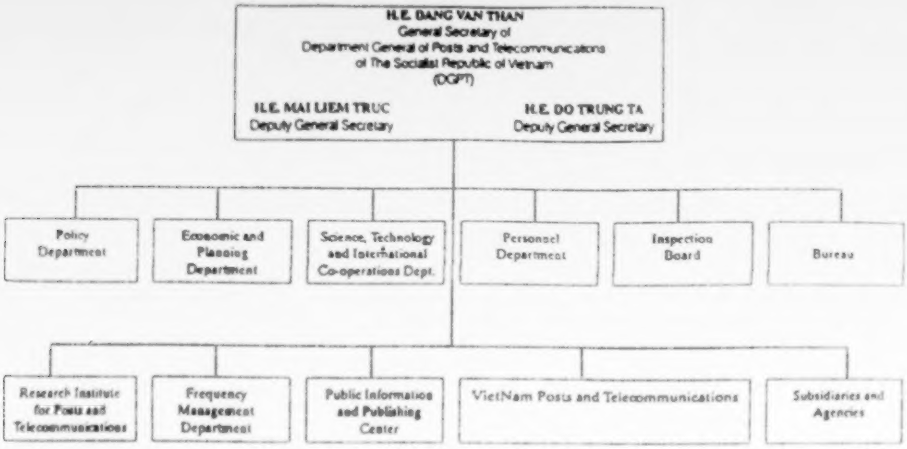
The main trunk routes within Vietnam are the responsibility of Vietnam Telecom National (VTN). VTN's role will include the operational control of the proposed microwave link at present being installed between Hanoi and HoChiMinh City and the various coastal cities enroute and the fibre optic network being installed as part of the telecommunications inter-city links.

(3) International Operations

Vietnam Telecom International (VTI) is the organisation responsible for all external telecommunications from Vietnam including operation of the INTELSAT and INTERSPUTNIK earth stations. The specific responsibilities of VTI include:

1. To manage, operate and develop the international telecommunications network and services of Vietnam;
2. To provide international telecommunications services such as telephone, telex, facsimile, data, transmission, international television and sound broadcasting, lease circuits etc;

STRUCTURE OF DGPT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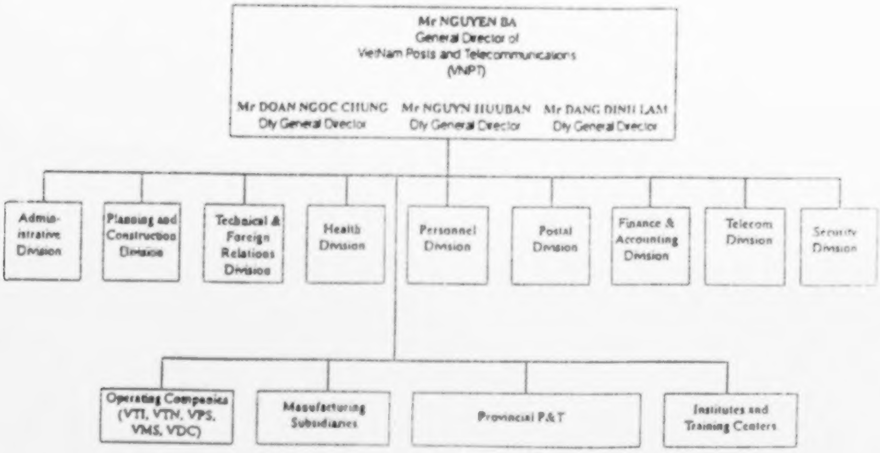
Policy Department
Economic and Planning Department
Science, Technology and International Co-operations Dept.
Personnel Department
Inspection Board
Bureau
Research Institute for Posts and Telecommunications
Frequency Management Department
Public Information and Publishing Center
VietNam Posts and Telecommunications
Subsidiaries and Agencies

STRUCTURE OF VNPT


Mr NGUYEN BA
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Mr DOAN NGOC CHUNG
Dty General Director
Mr NGUYN HUUBAN
Dty General Director
Mr DANG DINH LAM
Dty General Director
Administrative Division
Planning and Construction Division
Technical & Foreign Relations Division
Health Division
Personnel Division
Postal Division
Finance & Accounting Division
Telecom Division
Security Division
Operating Companies (VTI, VTN, VPS, VMS, VDC)
Manufacturing Subsidiaries
Provincial P&T
Institutes and Training Centers

Figure 2

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3. To provide satellite communication channels for domestic trunk networks and distribute to national television programmes via satellite;

4. Design and implement business co-operation contracts for international telecommunications services with overseas companies; and

5. To negotiate the type of services to be provided and accounting rates with over 200 international telecommunications service carriers worldwide. It is also likely that VTI will be responsible for the Vietnamese side of the proposed fibre optic submarine cable link to Hong Kong and Bangkok.

(4) Manufacturers and Importers

The VNPT has two subsidiary trading companies - Cokyvina in the North and Potmasco in the South. These companies are the main suppliers of terminals and office equipment. They import PBX telephone handsets, fax and telex equipment, local telephone cables, personal computing and printing, copying and other office equipment. They are also authorised by the VNPT to sign contracts with foreign suppliers for large projects. The VNPT is also a manufacturer, both in its own right and in joint ventures. Vietnam wishes to develop local manufacturing capacity and has entered into several agreements with foreign companies to co-manufacture in Vietnam.

3. INVESTMENT ISSUES

Investment Variation

The law on Foreign Investment was passed by the National Assembly in Hanoi on 29 December, 1987 and was amended in 1990 and 1992. This Act guarantees the ownership of invested capital and other rights of foreign organisations and individuals and provides favourable conditions and simple procedures for investment in Vietnam.

Foreign organisations and individuals may invest in Vietnam using any of the following vehicles:

(1) Contractual business co-operation agreement where two or more parties may enter into production sharing or other co-operation.

(2) Joint venture enterprise or co-operation

The foreign party to a joint venture enterprise may make its contribution in foreign currency, plant, buildings, equipment, machinery, tools, components, spare parts, or patents, technical know-how, technological processes and technical services. The Vietnamese party may make it's contribution in Vietnamese currency or foreign currency, natural resources, buildings, fixtures, or furnishings, the value in the right of land, water or sea use, plant, building structures, equipment, machinery, tools, components, or spare parts and supervision of construction and commissioning of plants, patents, technical know-how, technological processes and technical services. There is no ceiling on the proportion of contribution made by a foreign party to this prescribed capital of a joint venture. However the minimum proportion will be 30% of the total prescribed capital contributed by both sides.

(3) Wholly owned foreign subsidiary

At present, the infrastructure services such as the public switched network, may not be extended by the use of joint venture of wholly owned vehicles. This is purely a requirement of the DGPT and not the Foreign Investment Law. As a result, most investment with the DGPT has been by way of the business co-operation contract. However non-infrastructure projects such as radio paging and mobile services have to date been by either joint venture or a foreign owned subsidiary vehicle. These usually involve a contractual commitment by the foreign organisation to provide goods, services and training. In addition it is necessary for the foreign organisation to provide marketing skills.

The return on these investments in the telecommunications sector is usually by way of revenue sharing. At present the DGPT is considering other options such as build-lease-transfer or build-own-transfer arrangements.

All new businesses in Vietnam whether established through a business co-operation contract, joint venture or wholly owned subsidiary require licencing. The relevantcommercial arrangements are concluded with the DGPT Directorate but the DGPT in Hanoi is involved in the licencing approval process. The initial preference by the authorities in Hanoi was for fairly short term licences with a maximum term of five years. However companies who are willing to make a significant commitment may obtain longer term licences.

3.1 Taxation

The principal forms of taxation which apply to foreigners include personal tax with current rates ranging from 10% - 50%, direct tax on profit for foreign owned enterprises and those with foreign partners of 15% - 25% on profits. However enterprises with priority status are taxed at rates of 15% - 20%. Foreign parties are also liable to pay withholding tax on profits to be remitted overseas. These rates vary from 5% - 10% depending on the value of the share capital of the foreign owned companies or joint ventures. However if a foreign party reinvests any of the profits in Vietnam for at least three years the company may obtain a refund on any withholding taxes relating to the reinvestment amounts. Businesses with foreign invested capital, and or foreign partners are required to pay Business Tax on earnings derived in Vietnam.

In addition to taxes on foreign enterprises all goods entering or leaving Vietnam are subject to import and export duties. However deductions or exemptions may be given for certain classes of goods. Minimum tariffs are charged on goods exported to or imported from countries which have favoured status agreements for trade relations with Vietnam and for special cases approved by the authorities.

The Vietnamese authorities are in the process of creating export processing zones. The first one being considered is for the Saigon Export Processing Zone (SEP Zone). It will be the first in the country to offer potential investors a conducive investment environment, abundant workforce, broad incentives, and carefully designed services and facilities. The proposed SEP Zone will be in a suburban area about 19 klms from HoChiMinh City and 25 klms from Tan Son Naht International Airport. Land in the SEP Zone will only be available for lease with tenants enjoying various tax incentives commonly found in similar special zones in other countries. It is probable that a second zone will be located near Hiphong in the far north.

4. INTELLECTUAL PROPERTY PROTECTION

Trademark

The Vietnam Constitution and chapter 1 article 5 on the Decree on the Protection of Industrial Property gives the Council of Ministers responsibility for setting the policy on intellectual property. The Ordinance on Trademarks was promulgated by the Council of Ministers Order No. 197-HDBT on December 14, 1982. This Ordinance was substantially amended by Order No. 84-HDBT on March 20, 1990. Article 6 of the Order 84 significantly changed Vietnam's scheme of trademark ownership from a first-to-use system to a first-to-file system. Since only registered trademarks are protected in Vietnam, registration is essentially ownership. Under the first-to-file system, the first "juridical" person to file an application to register a trademark is deemed to be the owner of that trademark and disputes between two claimants will be settled on this basis.

Registration of trademarks is conducted by the National Office of Investigations under the State Committee of Science. Marks for goods or services may be registered using the international classification system. The examination by the National Office of Inventions (NOI) is a two-stage process. Initially the NOI would examine the form of the application as to whether the application is correctly made. The NOI will then examine the mark for substance that is whether the mark is registerable under the law. Essentially the mark must meet the same requirements for substance as is required by the Trademark Act in Australia. On passing the second examination, the NOI will enter the mark on the National Register of Marks, issue a certificate and publish the mark in the official Bulletin of Invention and Marks. The trademark is protected from the date the decision to grant the registration certificate is rendered. It is valid for 10 year terms. If the mark is not used without legitimate reason, for a 5 year period following registration it is vulnerable to expungment from the Register.

Should the trademark be infringed in Vietnam the registered owner has at least two paths of recourse, the administrative procedure and the civil procedure. However the trademark owner should attempt to settle the matter with the infringer before going to Court otherwise the Court will have little sympathy for the owner.

Since only trademarks registered in Vietnam are recognised in Vietnam and since the first-to-file a registration application is deemed the owner of the trademark, businesses should move quickly to apply to register their valuable trademarks.

4.1 Patents

In addition to trademarks, Vietnam has established relevant legislation for the registration of a patent which is defined as an invention, technical solution which represents worldwide novelty, or inventive step with applicability in social and economic fields. The object for protection of an invention may be a new device, a new process, a new substance or new applications of a previously known device, process method or substance. The term of validity of a patent is 15 years from the priority date of the application.

4.2 Utility

It is also possible to register a utility solution for a patent which means a technical solution which is new in Vietnam and applicable in the existing economic technical conditions. The subject matter of a utility solution may be advice, a process/method or a substance. The term of production for an utility solution is six years from the date of the priority of application.

4.3 Designs

Legislation also is in place for the registration of industrial designs which is defined as a specific appearance of a product embodied by lines, three dimensional forms, colours, or a combination of these which is now considered on a worldwide basis and capable to serve as a pattern for a product of industry or handicraft. An industrial design will be recognised as new if, prior to the priority date of the application for registration, that industrial design is distinguished substantially from other industrial designs of the same kind that are known in the country and or abroad and has not been disclosed anywhere under any form of publication, utilisation or any other form. The term of validity of the certificate of an industrial design is 5 years from the date of priority of the application. The certificate may be extended for two successive periods of 5 years each.

PLANITU Based Network Planning; An ITU-BDT Support To Indonesia

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1. ABSTRACT

Today, PT. TELKOM has moved its network planning process from a conventional way and fragmented one to an efficient, comprehensive and scientific one using PLANITU with a full support from the Telecommunication Development Bureau (BDT) of the International Telecommunication Union (ITU).
The success story of PLANITU implementation in Indonesia shows how the recommendation from independent commission for world-wide telecommunication development executed. From the experience of PLANITU implementation in Indonesia, it is shown that PLANITU is well suited to the developing country environment where the dynamic in planning is sometimes very challenging.

2. INTRODUCTION

In telecommunications infra-structure development, network planning is an activity that plays a very important role because a network development/ construction which is based on appropriate planning will result in a network with standard quality, which eventually will offer a good quality of network operations and maintenance as well as satisfying the customers. It is therefore the effort to establish a professional / competent network planning must be spent by any telecommunication operator especially the ones in developing country in order to get the best quality of its network and service.

PT. Telekomunikasi Indonesia (TELKOM), after a long observation and analysis has decided to move from a conventional way and fragmented network planning process to an efficient, comprehensive and scientific one using PLANITU with a full support from the Telecommunication Development Bureau (BDT) of the International Telecommunication- Union (ITU).

The implementation of PLANITU-based Network Planning in TELKOM has been done in a comprehensive manner which involves multiple organizations and multi nationalities.

This paper discusses the 'success story' of the cooperation mainly between ITU and TELKOM in the development and improvement of TELKOM's Network Planning capabilities using a computerized network planning tool PLANITU.
The intervention of ITU, backed up by funds from UNDP, has been an ideal example as how the recommendation from the independent commission for world-wide telecommunication development is executed.

3. PLANITU BASED NETWORK PLANNING

PLANITU was developed by ITU experts, partly funded by UNDP and has been introduced in many developing countries such as Colombia, Morocco, Tunisia, Bulgaria, Sri Lanka, etc., before TELKOM adopted it last year. As a computerized planning tool, PLANITU produces a network Master Plan at its most optimum configuration.

By utilizing PLANITU, TELKOM is able to perform an integrated top-down network planning in a very efficient way. In average, this approach of planning will result in a cost saving of 5 % during the network implementation phase. One of the key element in PLANITU is a set of microscopic data and based on that data the optimization of network is done. Data inputs are extremely vital and cover information that are required to produce a good Master Plan.
Since the operation of PLANITU a new dimension of Network Planning is introduced in TELKOM. Network planning has been transformed from a rather pure engineering activity at very low level to become a Planning activity that involves essential policies and a great deal of Planner's creativity in a much better way. This is true mainly because repetitive and tedious parts of the planning process are done by computer.

Matters that sometimes belong to managerial level of organization such as:

- where and when to introduce new exchange
- which exchange to be replaced
- how to rearrange its dimension and boundaries
- whether or not to use RSU
- what type of exchange or transmission equipment to be chosen
- Etc.

may be addressed by the management for presentation to the PLANITU as a network policy framework.

Generally speaking, PLANITU requires input data that could be classified into the following categories:

- The present network configuration
- Subscriber and traffic distribution forecasts
- Information of cost and technical specification
- Target of Grade of Services
- Other supporting data such as; specific geographic, location, boundaries that must be fixed, etc.

The biggest challenge of PLANITU lies actually on the quality of input data collections and management. The experience has shown that a considerable amount of managerial effort is required to ensure the continuous access to the data and the consistent updating of stored input data. Indeed one of the new dimensions that PLANITU has brought to TELKOM is actually the level of data awareness especially in planning activities.
Being able to overcome almost every single hurdle of data management process of PLANITU, TELKOM together with some foreign counterparts has even successfully developed some peripheral supporting software tools to improve the accuracy and quality of PLANITU data. One of the example of this is the PMCAD software that can transfer coordinate data from AUTOCAD format to the PLANITU format and vice versa. Another example is the plausibility check to the input data that is considered as a very important step to ensure the quality of PLANITU result. A PC based tools to perform this plausibility check has been completed very recently. Within relatively very short time, TELKOM has successfully been able to embark on the improvement of PLANITU's data inputting mechanism.

A computerized long-term oriented tool like PLANITU is well suited to the developing country environment where the dynamic in planning is sometimes very challenging. Planning practices in developing countries in many cases has not yet been established because of scarcity of resources.

Changes in policy, modification of approach, introduction of new strategy and target due to technological changes will affect the network development strategy and scenario. These changes can be easily accommodated by PLANITU. The Planners job is very much eased by the computer work and somehow the network development scenario can always be monitored/ controlled.

4. PLANITU IMPLEMENTATION IN INDONESIA

Indonesia is the largest archipelago in the world, stretching more than 5,000 km from east to west and about 2000 km from north to south. Sea covers 75 % of this area. The country consists of 13,700 islands of which only 7 % are inhabited. The land area is nearly two million square kilometers. Indonesia has a population of 183 millions and will soon embark on the second stage of the 25 years long-term National development program. Indonesia is also known as a country with endless diversity, in people, culture and socioeconomic development stage of the regions. it is therefore undoubtedly impossible for a vast, archipelago country like Indonesia, with diversities in all major aspects of the national life to centralize a planning process in a certain location serving the whole country. Domestic telecommunications service is provided by TELKOM together with two newly emerging operators which have been licensed recently by the Government namely SATELINDO and RATELINDO.

Until 1992 the network planning practice in TELKOM has been very practical at a very low level of the process. Network Planning was known as a detailed implementation planning activities, segmented to switching, transmission and Out Side Plant planning. This planning practice imposes a situation where the planning results of each segment are practically unconsolidated. In the past, on the other hand the high level portion of network planning has been relied very much on the external support from consultants. They have been ordered to produce network Master Plan for certain geographical area. The results of their work would then be adopted as the basis of detailed implementation planning which normally follows.

Some voluntary effort to develop internal capabilities in strategic Network Master Planning were observed in the past but since this effort is not coordinated the result came out in the form of varieties of Software tools, data and of course, varieties of Network plans.

After many years of the absence of standardized and solid network planning method and facilities, the ITU and TELKOM agreed in 1991 to cooperate, to implement PLANITU as a standard for strategic network planning methodology in TELKOM. Both parties agreed to run a 10 month on the job training program in TELKOM Training Center Bandung in the year 1992. There were 25 trainees from TELKOM and several experts from ITU, partly full time and partly part time.

The training was really excellent. TELKOM's engineers were very enthusiastic to have this standard planning tools running and indeed it has been the motivation for the trainees so that they were committed to embark on the development of the Master Plan of Jakarta Network. Intentionally Jakarta network was selected because of its complexity and its performance. After an intricate discussion with the lecturers from ITU, finally it was agreed to adopt Jakarta as 'a case' for the on the job training (OJT), with the hope that once the master plan of Jakarta network can be produced, other master plan for regional networks in other areas or cities will follow relatively smoothly.
During working on Planning of the Jakarta Network some major problems were encountered, mainly in input data areas. In some cases the available data did not meet the PLANITU input data requirements. At the end of the on the job training it became apparent that the adoption of Jakarta network as a test case was a right decision because:

- The trainees, who were mostly young and fresh planners, had to encounter the most intricate process in data collection and processing.
- The PLANITU tool has been loaded with an enormous amount of data to produce a master plan which is huge in size.
- The master plan of Jakarta network was successfully produced which proofs the applicability of PLANITU in Indonesia.

"This success story" has encouraged the involvement of German government in the implementation of PLANITU through out Indonesia as an important part of TELKOM's network planning upgrading, a project which is currently underway under government to government cooperation scheme. Today the PLANITU has been endorsed by several regions in Indonesia and is planned to be completed by the end of 1994. The major impact of the PLANITU implementation results is an upgrade of the quality of planning in PT. TELKOM which in turn will ensure the quality of future network expansion in Indonesia.

a) ITU SUPPORT

The ITU has granted the PLANITU user right to TELKOM and has largely assisted TELKOM in implementing PLANITU in Indonesia. As described in detailed above, the very first program of cooperation was executed through seminars and OJT which covers several major activities:

- data collection method and
- data analysis and processing
- PLANITU set up, operation and maintenance

The ITU support will be extended to the period after the first OJT was over, some joint activities between TELKOM and ITU have been agreed covering:

- Implementation of short-term planning function in PLANITU
- Development PLANITU for future systems and technology
- Inclusion of TELKOM's Planners to the future activities of ITU in introducing PLANITU in other countries.
- Organizing of PLANITU courses in TELKOM's Training Center for TELKOM's employee as well as for foreign operators.

b) TELKOM MANAGEMENT SUPPORT

Management support was a key factor that has ensured the successful introduction of the PLANITU to TELKOM. The major issues that go along with the introduction of the tool are standardization of the planning tool and method within TELKOM and decentralization of the planning function to the Regional Operating Offices of TELKOM. Both issues require a large amount of management effort to realize, because of the huge size of TELKOM in terms of locations and number of regions (i.e, 12 Regional Operating Offices)

Standardization needs a lot of marketing effort but, it is considered as mandatory for TELKOM to be able to consolidate regional master plan in the national level and to be able to interpret, exchange and process data between head office and regions and doing planning uniformly in the whole organization. The adoption of PLANITU as a standard method of network planning will also transform TELKOM to be an operator which employing state of the art information technology solution in its network planning activities, which in turn improves TELKOM's efficiency and development capacity that will soon approach 1 million lines a year.

Decentralization, on the other hand, is much more intricate since it involves education of people, organization set up, establishment of computer facilities. TELKOM is fortunate in this regard to have an assistance from the German government through the government of Indonesia to run a model in Surabaya (East Java province) for network planning decentralization. The ITU, TELKOM and GTZ (German) were able to harmonize efforts from each party to become a real synergy. The joint activities are underway and have been able to reach some important milestone:

- Software tools for plausibility check.
- Data collections and processing for Surabaya city.
- A concept on the Regional Network Planning Center (RNPC) organization.

The decentralization effort is closely tied to the standardization process. If the marketing of this new concept and approach on long term network planning through PLANITU is successful, then decentralization could be much simpler. RNPC is designed to cover every aspect of network planning, both the long term master planning and the detailed implementation planning.

The existing planning offices for switching, transmission, OSP and supporting facilities will be maintained and at the same time linked to a 'higher level' planning office that deals with master plan. Starting from 1994, each of the dedicated planning offices has to base its work on the master plan produced by the master planning office. In head office, a National Network Planning Center (NNPC) has still to be maintained for the back bone national network.

The availability of Human Resources experts will determine whether PLANITU-based Network Planning in TELKOM can develop and grow in the future to cope with technological developments. Realizing this, TELKOM Training Center was involved during the introduction of PLANITU. As a result of this involvement of the Training Center, TELKOM is now establishing a complete training path as how an engineer can be educated to become a competent network planner for both long-term and short-term network planning. With the support of ITU's experts, the training path as indicated in figure 1 bellow is now being implemented and TELKOM Training Center is prepared to be the school for PLANITU-based network planning for domestic as well as foreign trainees. The ITU

5. CONCLUSIONS

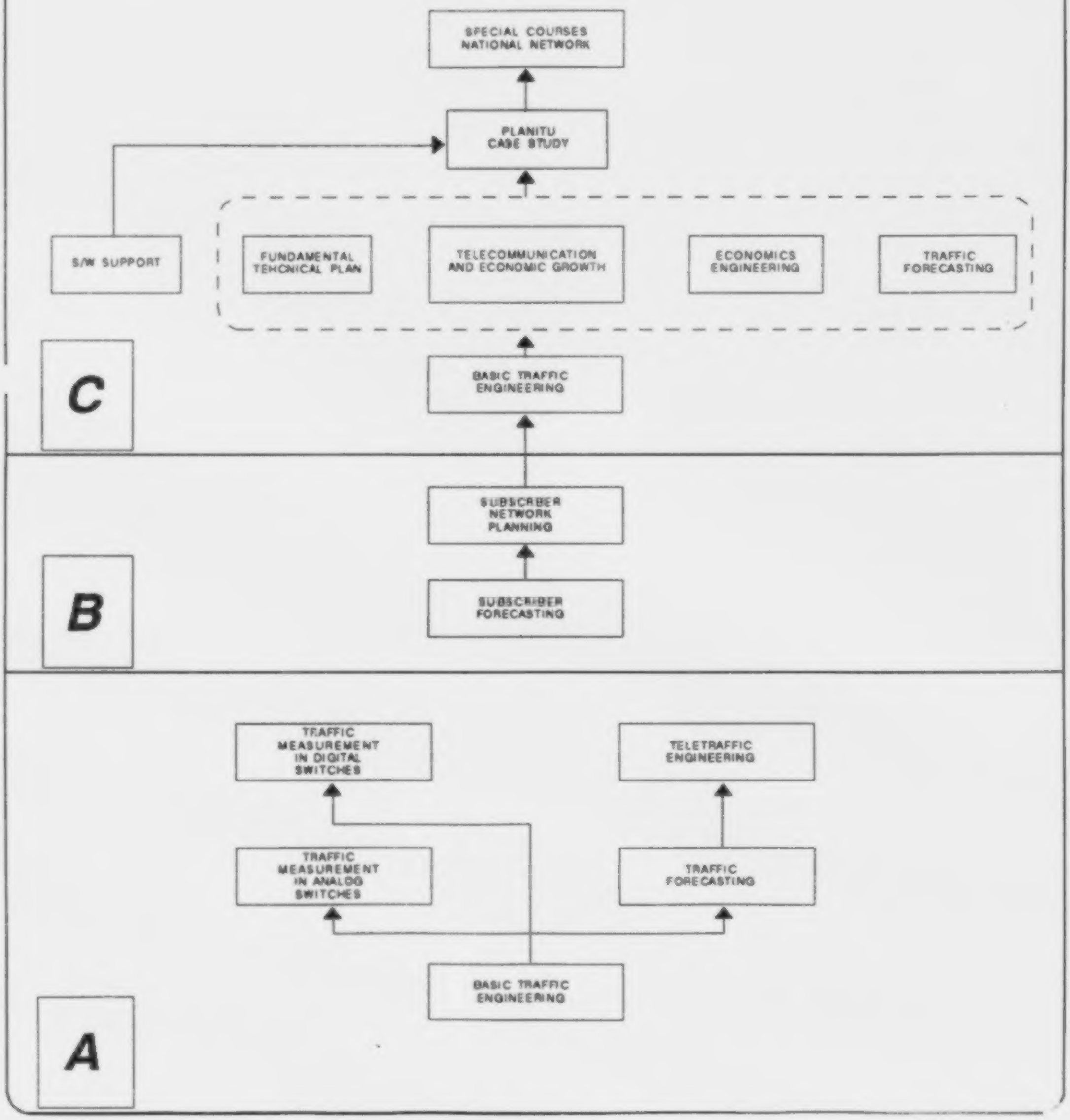
- PLANITU-based network planning has been successfully introduced in Indonesia as a multiparties and multinationals project and has improved the efficiency and quality of TELKOM's Network Planning as well as modernize it. The PLANITU introduction in Indonesia is an ideal example of how the global telecommunications family can cooperate and work hand-in-hand to improve the global telecommunications network for the benefit of all nations. A message that is conveyed by the 'missing link report' of the independent commission for world-wide telecommunications development.

- PLANITU is a media for telecom operator in developing economy to upgrade their planning efficiency and quality so that they can embark on a large scale telecommunications infra-structure development program that is normally required in countries with very low telephone density. The huge demand of telephone in Indonesia which amounting to 1 million lines a year can suitably be supported by the PLANITU.

- As technology progresses, PLANITU shall always be updated and upgraded to deal with new kind of product and technology. This paves the way to new opportunities for TELKOM to contribute to the development of sophisticated network planning tools.

Figure 1

TRAINING PATH
FOR
TRAFFIC ENGINEERING AND NETWORK PLANNING


SPECIAL COURSES NATIONAL NETWORK
PLANITU CASE STUDY
S/W SUPPORT
FUNDAMENTAL TEHCNICAL PLAN
TELECOMMUNICATION AND ECONOMIC GROWTH
ECONOMICS ENGINEERING
TRAFFIC FORECASTING
BASIC TRAFFIC ENGINEERING
C
SUBSCRIBER NETWORK PLANNING
SUBSCRIBER FORECASTING
B
TRAFFIC MEASUREMENT IN DIGITAL SWITCHES
TELETRAFFIC ENGINEERING
TRAFFIC MEASUREMENT IN ANALOG SWITCHES
TRAFFIC FORECASTING
BASIC TRAFFIC ENGINEERING
A

Outline of Activities for International Cooperation and Their Problems

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Abstract

In the telecommunication field, international cooperation activities have been changing due to the recent structural reform including privatization or competition, and a lot of new type of cooperation activities such as joint venture, BOT type activities have been carried out. This paper, however, focuses on the traditional type of cooperation activities which are indispensable for fundamental improvement in telecommunications infrastructure in the developing countries. Furthermore, some problems now we are facing in these activities and their solutions are pointed out in this paper.

1. Background of International Cooperation

The benefits of telecommunications as a social structure can be, if not quantified, easily recognized. An efficient telecommunications system promotes not only the national and international exchange and sharing of information, but the integration of society, with its immense effects on social activities. A well-organized telecommunications network is an indispensable element for a nation to develop, and in this sense, the developing countries can achieve growth only after establishing a telecommunications system as their infrastructure. However, they lack in financial and human resources to enhance their telecommunications systems well enough to be workable for that purpose. There lies a reason the cooperation by the industrialized countries is required. Another cause of international cooperation is stemmed from the fact that international telecommunications is carried out under a kind of joint venture where in domestic and international telecommunications facilities of the participating countries are used mutually, thus making coordination and cooperation indispensable. To achieve smooth communications, it is necessary to mutually maintain the levels of facilities, technique and operation on a par. For international telecommunications service providers, any development of telecommunications on the side of their counterparts means the improvement of communications of their own.

It is for these reasons that the international cooperation in telecommunications is firmly linked to the nation's industrial or diplomatic policy. Meanwhile, with the recent structural reform in the field of telecommunications, the stand of international cooperation in this domain has also been changing: the competition introduced into telecommunications in many industrialized countries including the United States, the United Kingdom and Japan have forced the telecommunications service providers in these countries to take measures to increase their income for survival not only by securing a comfortable market share but by the making inroad into a new market. The international cooperation in this context is sometimes regarded by the developed countries as a measure to improve profitability by establishing new direct circuits or enhancing the throughput rate, as well as to secure a new business opportunity in the hope that the cooperation in these forms will be turned into an edge in taking the leadership in the formation of a new telecommunication order. At the same time, some developing countries are very keen to import foreign capital and technology with a view to using them as a leverage to improve their infrastructure. Giving a helping hand to this objective may not come under the so-called international cooperation. It should be noted, however, that in recent years the boundary between the partnership undertaking and the aid has become increasingly blurred in the field of telecommunications. This presentation, however, focuses on the so-called cooperative activities in the developed and developing countries relationship, those to be pursued, not by mere private enterprises but by organizations of public nature with intent to contribute to the development of other countries under the initiative of the governments concerned.

The significance of cooperative activities for the developing countries is twofold: for one thing they contribute to the development of recipient countries, and for the other the improved telecommunications realized as a result of such activities leads in turn to the betterment of the services provided by the donor countries.

2. Examples of cooperative activities

International cooperative activities include many forms of activities from the granting financial aids to the acceptance of trainees. In this section, KDD's international cooperative activities are mentioned as examples. Activities have been yearly expanded and diversified to include the dispatch of experts, group training, and engineering consultancy.

2.1 Acceptance of trainees

Since 1962 KDD has been offering group training courses for trainees from the developing countries. Training of this kind which forms a part of ODA (Official Development Assistance) programs sponsored by the Japanese Government is mostly carried out by public or private organizations under the commissioning of JICA(Japan International Cooperation Agency). The group training is conducted in the following manner: first, curricula are worked out on the subjects commonly required by the developing countries; then, the training programs are sent to the governments concerned to recruit participants. Each course is offered to 10 to 15 trainees for about two months. In addition to the group training commissioned by JICA, KDD is offering individual training courses depending on different demands in respect of the subject and the training term. The organizations which have so far asked to provide individual training courses include APT(Asia Pacific Telecommunity), telecommunications service providers in other countries and INTELSAT. These training courses are aimed at improving technique and know-how commonly required by the member countries of APT or INTELSAT, and is serving the development of telecommunications and the expansion of telecommunications networks in the members countries.

2.2 Dispatch of experts

The purpose of dispatching experts is to transfer technique and know-how to developing countries, and contribute to the fostering of skilled personnel. Main areas of tasks at the telecommunications administrations or operating organizations where these experts are assigned are consultancy of the planning of telecommunications businesses and guidance on the operation and maintenance. The programs for dispatching experts are prepared by, in addition to the governmental organization like JICA and other public organizations, the international organizations such as ITU and APT as well as telecommunications carriers.

2.3 Memorandum on technical cooperation and provision of equipment

Staff exchange program is also included in international cooperative activities, and is based on the memorandum on technical cooperation agreed with its counterparts of the countries with which Japan has a close relationship with considerable amount of international traffic. Under this scheme the exchange of technical information or personnel is performed. Furthermore, with intent to improve the quality of communications services as well as to support training of the technical personnel, KDD has established its own scheme to provide gratuitously, at the request of corresponding telecommunications organizations, telecommunications equipment and measuring instruments.

2.4 Consultancy

Overseas consultancy constitutes one aspect of the technical cooperative activities for telecommunications projects undertaken by overseas telecommunications organizations. It begins with the identification of projects to be implemented under ODA, and then proceeds to planning of the construction and procurement, assessment of proposals, advice on the construction work, followed by guidance on the operation and maintenance of the facilities completed. As compared with the acceptance of trainees or the dispatch of experts, from viewpoints of the improvement of telecommunications in the countries concerned, short-term and direct effects can be expected from consulting activities.

3. Training

There are various cooperative activities undertaken by telecommunications carriers, the significance of "training" performed through the acceptance of trainees and the dispatch of experts is detailed in this section.

" The Missing Link", report of the Independent Commission for World Wide Telecommunications Development, points to the causes developing countries are lagging in the improvement of telecommunications as follows:

- Developing countries lack sufficient trained staff
- Satisfactory arrangements for training staff at all the levels are essential for any telecommunications operating entity

It seems to be unrealistic to think that much has been done to change such a situation during ten years since the report was published. In international telecommunications, in order to achieve smooth operation and the improvement of service quality, the technical standards have to be maintained at the equal level between/among the countries involved, and efficient operation will not be assured until this is realized. For this reason, the outcome of innovation achieved in one country must be transferred to other countries yet to accomplish innovation. In this sense, cooperative activities will see no end in the field of telecommunications, and the significance of training lies there. Recently, some developing countries which have extricated themselves of United Nations defined as "developing country", but still remain as a recipient country of training. To get the donor and recipient relationship dissolved into a new one, such countries could better be regarded by the developed countries as "equal partner", with whom efficient operation of the network and the improvement of service quality are sought through the exchange of the latest technical information. Yet, as indicated in the report, many countries still remain in the state of "development aid for telecommunications in the developing countries should aim first and foremost to train manpower." Bearing in mind the ideal that training activities are indispensable for developing countries, telecommunications carriers in advanced countries should positively perform for the developing countries, but at the same time they faces many problems which cannot easily be overcome only by the principles or good-will. It appears that these are not peculiar to one carrier, but the kind of problems that every earnest provider of training is apt to face to some extent.

4. Problems encountered in training

4.1 Difficulties in cross culture communications

Among the problems to be tackled when

engaging in international cooperative activities, the one that is conspicuous, yet hard to overcome is the problem arising from differences in the culture and manner of living. Language, manners and customs differ from each other between recipient and donor countries, and in such circumstances it is quite difficult for both to achieve smooth communications and exchange information sufficiently and precisely. These difficulties have often been talked of by experts and instructors. Among others, a grave concern is expressed about the problem of language. English is used in training, since majority of trainees come from the countries which use that language as their vernacular or the second tongue, but failure in training can occur when either side of the instructor or the trainee has a language problem. In the case of a problem on the instructor's side, its solution seems to be rather simple. The only thing to do is to improve his language ability. On the other hand, when the trainee's side is responsible for the failure in understanding, this can pose a rather complicated problem, because the language difficulty may be rooted in the educational system of the country the trainee comes from. This seems to become more probable when we see that although English is widely used in the trainee's native country, and no problem is raised in communicating in English with the manager class personnel of that country, some working rank personnel cannot speak that language. For experts dispatched, knowledge of the vernacular may be needed in case of participating some meetings, or for attentive instructions, but training in any vernacular is rarely carried out.

4.2 Difficulties in meeting requirements for training

A lot of problems arise from inability on the side of donors of identifying real requirements for training. For recipient countries of experts, a well-organized preparation is a prerequisite if guidance on some technique is to be sought from a developed country. In spite of this, it is often the case that some developing countries require technical guidance even from this initial stage of preparation. Another cause of the problem of this sort is stemmed from group training. In group training, a dozen of trainees from different countries attend the same subject and it sometimes fails to fulfill requirements of all the participating countries. This often happens when the state of things like the level of technology or knowledge, or information required is in variance among the countries sending trainees. In a group training course in data communications technology including OSI, packet switching and MHS conducted by KDD as a part of APT training program, it was revealed from the follow-up questionnaire that there had been a great deal of difference in the extent of understanding, as well as in applicability of the lecture to the respective future planning, between the countries where the introduction of ISDN or the purchase of a packet switch was planned, and the countries where data communications are confined to teletype traffic or the air-ticket reservation system. Primarily, if some training is intended for immediate application, it should desirably be conducted for the country concerned, but as compared with group training, individual training tends to impose financially and physically heavy burden on the host country.

4.3 Difficulties in follow-up

In international cooperative activities including training, confirmation of their results is important on the donor country's side, and their tangible outcomes or feedback on the recipient country's side. However, job switching of the trainees soon after training, or monopoly by them of acquired expertise is a story often heard of. Unless acquired knowledge is put into practical use or opportunely refreshed, it will turn into "a treasure useless." Beyond this, coming across several instances wherein a right person has not participated in a right training as exemplifed by attendance of a telephone operator to the lecture on satellite communications technique, we become all the more skeptical about whether the feedback has been done properly. Follow-up activities are essential in that they contribute to overcome the problems as indicated above, to turn expertise or technique acquired to practical use by getting it firmly planted in the recipient country, and for the donor country to improve curricula for future by identifying the points requiring revisions. But follow-up activities are easier said than done. In particular, how to utilize knowledge acquired is not a matter for host countries only. The problem also concerns individual participants as well as the recipient country. For recipient country, solution of this problem depends on whether or not they can create setting for the purposeful application of expertise acquired. Apart from this, it would be practically impossible to pursue the current status of every graduate of the training in order to keep contact with him/her.

4.4 Other difficulties

There are some problems arising from statutory procedural matters. The complicated emigration and immigration procedure are one example. When the APT sponsored group training courses were given by KDD in satellite communications technique in 1991 and 1992, the trainees from Afghanistan could not visit at all on one occasion, and arrived at a later date in Japan on the other occasion, because of the protracted process of procedures for obtaining visa. Poor communications with the recipient country also tend to cause trouble when accepting trainees. Apart from this, KDD has once heard from a trainee a criticism for Japan's reluctance to disclose advanced technology. But, however demanded, certain technology cannot be disclosed in training if it is protected by the right of intellectual property. Another knotty problem is scarcity of qualified instructors in particular when training in advanced technology is requested. Engineers with knowledge on advanced technology are too busy with their own tasks to be available for training.

5. Measures for settling problems

5.1 Practical measures for training

Several measures have been conceived to solve the difficulties in training as indicated in sections 4 and 5, and some of these measures have already been in practical application.

1) Pre- and Post-test for assessing effects of training

Tests conducted prior and subsequent to training will permit the host organization to know not only how each trainee has advanced as the result of training, but what is required to keep training at a desired level. The results of these tests can be used to review the methods of training. The chart 1 given shows the results of the pre- and post-tests for the training in satellite communications technique conducted by KDD early 1993 (The questions concern the basic technology of INTELSAT satellite communications system, and the operation and maintenance of the earth station. See the chart 1). From the chart, we have learned that the training was a success, bringing about advancement in trainees' knowledge on the satellite communications.

2) Third country training program

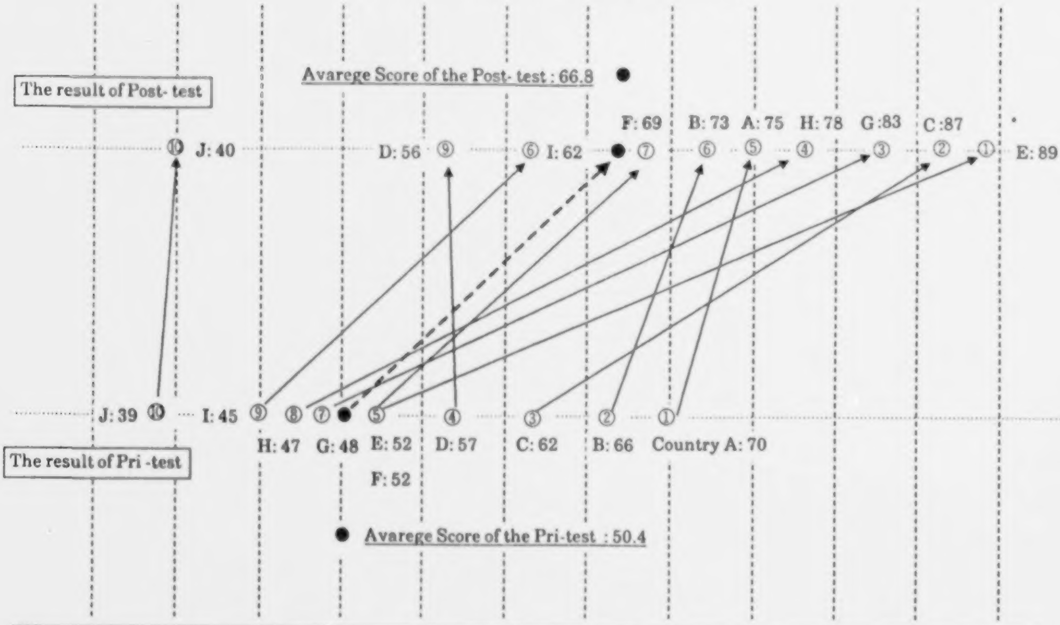
In some cases training can produce better results than those achieved in the donor country, if it is carried out in a key country chosen from among several countries sharing a common basis for social structure, cultural background and language. (In this case, the expert is dispatched to the chosen country from the host country.) Especially, this method is effective not only to solve the problems arising form differences in requirements for training or in manners and customs, but to transfer technology and know-how suited to a particular region.

3) Follow-up

The measures adopted by JICA, one of the Japanese organizations for international cooperation, appear to be very suggestive for other cooperation organizations in carrying out follow-up activities. The measures include the

Chart 1

1993 APT Satellite Communications Training Course (conducted by KDD)
Pri -test / Post-test Score Disribution Map



dispatch of itinerant instructors, encouragement to organize a kind of alumni association, and forwarding of the publications. The main tasks of the itinerant instructors are to call on the graduates having attended lectures in the same domain to have a hearing on their activities after returning home, and to give a seminar on the latest technology adopted in Japan. The setting up of an alumni association is helped financially by JICA. The document materials sent comprise of the technical periodicals and books, and the sending is aimed at introducing the latest information on Japan and advanced technology. Similarly, since 1965, KDD has been sending yearly a total of 2,600 copies the quarterly magazine, "KONNICHIWA" to 111 countries in order to keep contact with the graduates.

4) Certification

Training in Japan lasts only three months at the longest. It is reported that in Germany and the United Kingdom there are some courses which last as long as two years and qualify the participants for a higher position. If the acquirement of expertise as the result of training is associated with some qualification and the up-grading of career, technical know-how transferred would further be got rooted in the organizations which have sent trainees. However, such measures could not be implemented until the governments or the organizations concerned have agreed on some concerted and coordinated methods.

5) Establishment of training center

The establishment of local training centers would be another effective measure to carry out training suited to a particular region and get the results firmly settled in that region. This measure will of course require concerted efforts of both the donor and the recipient countries. In the highly innovative fields like telecommunications, efficient transfer of technology based on the latest information is essential so that the recipient country can keep abreast with the development, and the local centers will do much toward the purpose. In some cases, local universities or higher educational institutions can play a role of the local training center.

6) Education for training specialists and data base for know-how

Aside from the organizations specialized in cooperative activities, the actual knowledge gained by training specialists from experiences in foreign countries in international cooperation is apt to be covert as personal know-how. However, to carry out cooperative activities of a higher quality, it is necessary to accumulate in a database information on the state of things in the countries visited including social communications and living conditions, as well as know-how on how to cope with the problems likely to arise when living there. At the same time an educational system to secure training specialists is essential. Furthermore, it should be noted that experts have to engage in technology transfer while undergoing the mental and physical stress due to different cultures, and that they sometimes lose sight of the results of their efforts, because of a social system different from their own. In view of these facts, a national system to support experts dispatched may need to be established.

5.2 General measures for cooperative activities

1) Qualitative improvement and quantitative expansion of cooperative activities

In spite of the positive cooperation by the industrialized countries there still remains a technological gap between the developed countries where the advanced information network is being constructed and the developing countries where even the telephone network is far from being complete. Recently much debate has been voiced on the quality of cooperation, and in order to narrow down these gaps, improvement of the quality of cooperative activities is indispensable. This objective will require our effort, in particular, to serve well-qualified lecturer and instructors, as well as to work out cooperation program which meet the requirements of the recipient countries. In doing so, we will have to grasp what are indispensable and immediately required. Especially with budget not sufficiently allocated, the first thing to do so is to project and select what is required by recipient countries. Quantitative expansion in the cooperative activities should also be sought, before merely trying to expand the finance related to cooperative activities, we should eliminate waste to reduce the total cost per cooperative activity, and to expand the total number of cooperation programs.

2) Roles of international organizations in cooperative activities

International organizations such as ITU should play an important role in the international cooperative activities as referred in "The Missing Link" and the report recommends ITU to set up a kind of fund and keep the financial resources for enough investment to the developing countries. Though it will be the efficient way for helping developing countries, other tasks it has to assume include to help developing countries with drawing up a basis plan (to the extent not to meddle in their domestic affairs) and to take the initiative in aid coordination. As shown in the past instances, lack of concerted activities often hampers the effective use of resources perpetually limited and the full operation of facilities constructed with technical aids, thus leading to failure to raise funds for the future investment. They should also take initiative in identifying requirements of the developing countries, making the most of their expertise and extensive communications channels.

3) Encouragement of the recipient countries' own efforts

With the increased financial and physical burdens on the developed countries engaging in cooperative activities, the burdens to be shared by private sector is becoming heavier as well. In this situation telecommunications carriers engaging in cooperative activities while surviving on its own business may well expect efforts on the side of the recipient countries. For example, the recipient countries should create an environment in which trainees can plant their knowledge and technologies in their countries properly and efficiently after coming back to their organizations. This may include giving trainees certain qualification, and accumulating the knowledge and information in a kind of database. Furthermore, the importance and effect of improvement in telecommunications infrastructure should be recognized seriously and have to be given a top priority by the government in the developing countries.

6. Conclusion

The rapid innovation coupled with keen competition in the field of telecommunications makes it difficult to foresee a new telecommunications order to emerge in future. It is a stark reality that the developing countries are severely wanting in ability to improve telecommunications services for themselves, and that the development of communications and the expansion of telecommunications network in these countries may partly be realized only with technical and financial aids from the industrialized countries. Such a situation is expected to continue still for years to come, and therefore it is safely assumed that a new telecommunications order in the formation will be the one based on a strong tie-up between the industrialized countries offering technology and funds, and the developing countries making the most of them. When a new order is on the topic, concern tend to focus on the business supremacy assumed by major telecommunications service providers as is the case with the strategical partnership, but the influence of the relationship between developed and developing countries on a new order cannot be ignored. In this sense, due deliberations should be devoted to the questions what international cooperation should be, as well as how the international organizations should be involved in them.

PTT RE-REGULATION: THE COORDINATION OF TECHNICAL, LEGAL AND REGULATORY ISSUES

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ABSRACT

The Traditional role of the National PTT (Posts, Telecomms, and Telegraphy) resource is under pressure for change. These pressures, stemming from market forces and technology advance, converge to force governments to review their national telecomms infrastructure, its availability, and its use. Methods of management of information distribution and consequently the information-dependent social order are principal targets of this force. Changes must be coordinated to structure their effect upon economies and society at large; the PTT must respond positively to survive. A clear separation of technical issues, legal constraints, and resource management (or regulation) must be made but must be made in a coordinated way. This paper sets out these issues and identifies solutions appropriate to the problems this new environment creates.

THE PTT ENVIRONMENT

Telecommunications is a National resource essential to economic and social health. Moreover, it is an obvious candidate for monopolistic supply and use: there can sensibly be only one network, (or a multiple of networks intimately connected each to the other) and the equipment which connects to the network must be technically compatible with it. The penetration of network ends determines to a large extent the ability to transfer information from one segment of society to another: and information is, today, the oil for the machinery of civilised living.

It is not by accident that one of the highest priorities in time of civil crisis (disorder or disaster) is the control and management of the telecommunications infrastructure serving those affected.

It is hardly surprising that telecommunications has evolved to the critical position it occupies in today's society; it is perhaps even less surprising commonly to find the whole of the resource either wholly controlled by the State or the property of Government. Indeed, many States consider the importance of their telecomms infrastructure and its management to stand alongside the importance of their military machine.

Any telecommunications infrastructure is hopelessly complex. To be useful, it must support a population of terminals and interwork with any number of other networks: the constraints in technical architecture exist at both the 'end' of the network and the 'middle'. There must be technical harmony throughout. And the entire information machine must be maintainable, growth-friendly, and sustainable. Many countries have developed -- by subsidy or direct national investment -- a technical industry to supply the components of their infrastructure. Many cannot rely -- or are hesitant to rely -- upon foreign interests to sustain such a key component of their nation's fabric. There is considerable pressure therefore to develop an infrastructure of home-grown technology: from telephone instrument to trunk exchange or from copper in the ground to the switchboard operator.

This, then, is the PTT of tradition. State-controlled labour to sustain and to provide the service which is effected by State-controlled industry and regulated by the Civil Service. State-owned vehicles attending home and business premises to connect (or to repair) State-owned telephone sets made by State-owned industry. State-determined services offered to the user population by means of this resource: and financial return retained by the National Treasury.

And, to cap it all, financial return of impressive magnitude available to the Political system for its own use.

TODAY'S COMMERCIAL REALITY

Technology put Man on the Moon nearly a quarter of a century ago: since that time, information-intensive industry has exploded. Transportation to all affordable by all is commonplace; the silicon chip has pushed intelligence from a central source into every corner of our lives -- from the wrist watch to the domestic washing machine. Technical complexity, a shrinking world, and the economic pressures of a developing global economy are making their mark.

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It is common today to find the lion's share of any technical machine to be in software: and software is produced by hand by a highly-skilled workforce. It is expensive and can be understood (and hence adjusted or modified) only by the initiated few. Hardware costs have reduced almost to throw-away dimensions. These factors shape a new environment in telecommunications: a user population with wants of greater sophistication and functionality, coupled with a manufacturing base of highly-skilled labour imposing immense costs (both in financial and human resource investment terms). It is often found simply not possible for industry to afford such an activity without the reality of expanding market presence beyond a national boundary. It is often found, too, that the user community tailors its social and commercial activity to features and facilities afforded by this new technology: one feeds upon and provides food for the other, and the cycle self-propagates. Because these factors are the product of human want, it is difficult to limit and perhaps virtually impossible to stifle such growth.

The detailed implications of this new environment upon the telecommunications resource force change. The cost of building networks approaches the medium-term return they might earn; the cost of procuring both terminal equipment and network equipment approaches short to medium-term return deriving from its use. The availability of information feeds the human need for more information: and the user population is prepared to pay.

These factors create pressures greater than even the tradition of the PTT can successfully resist. Terminals proliferate whilst costs drop; new networks with their sophisticated technology seek users to serve. Information-intensive industry has developed and seeks markets to sustain its growth.

The traditional PTT is quickly becoming history: but its critical role in social order remains. It cannot be eliminated: it must respond to and adapt to these pressures for change. And to survive, the adaptation must be ordered: the factors of technical change, the financial security of both infrastructure provider and user (by way of Law) and of Government (by way of State control or regulation) must be changed, yet preserved.

A NEW ARCHITECTURE EMERGES

It is clear that any response by the PTT structure arising from these pressures is commercially led. It is perhaps equally clear that financial strictures upon Government are greater today than at any other time in recent history. Moreover, the International market-place with its information-intensive product base seeks sustenance.

These factors create -- or cause -- a new look to be taken by Government. The central need to manage and to control to some extent the National telecomms resource remains: the question is perhaps how to sustain this dominance in an environment punctuated by commercial factors. Clearly, the State must continue to control: Clearly, too, the market needs a marketplace. The parameters of this new architecture emerge: the State must retain control, but by means of a mechanism different from absolute ownership of the infrastructure and the industry which fabricates its components; more market players insist on equitable market entry and commercial risk; and users wish to determine, at least in part, the nature of the resource to hand.

The migration path becomes visible: a State Regulator capable of managing networks, terminal supply, and network-borne services is appropriate; a market-sensitive machine able to define markets and marketing rules is a necessity; and given an ability clearly to distinguish between the network *per se* and the terminals it uses and the services it bears, there is a clear case for separating from all other components of the resource the network activity itself. Thus emerges a number of separate but linked activities, each with its own interdependent locus: The Regulator, managing (still) the resource; the Public Network Operator (or Operators), providing the pipelines; the market itself, supplying terminals from which and to which information can flow.

Each of these activities carries with it its own 'activity manager': the Regulator, serving Government; the Network Provider (or Providers), serving the Regulator and the marketplace alike; the terminal and services markets, serving their market places according to rules setting out how the market functions (and thereby the Regulator); and, to complete the picture, Government serving (in most cases) the society itself.

Such a structure remains stable, not because of powers imposed unilaterally from a central point (as in the traditional PTT situation) but because of a distributed set of accountability pressures which balance each other.

To sustain such a structure requires forging new tools. Some, legal; others, technical; all, with a mixture of each ingredient. Many of these tools do not exist and do not need to exist in a traditional PTT environment. All, because of the basic nature of their interdependence, need carefully to be constructed.

THE TECHNICAL DIMENSION

It is in the new environment that Standards (as opposed to recommendations on the one hand and specifications on the other) assume an essential role. Standards are required to define the technical characteristics of terminals manufactured outside the control of the network operator -- a key component of a competitive marketplace supplying terminals which will interwork with a network successfully. Terminal Standards must not contain non-tariff trade barriers to any market player -- and this means a mechanism of standards generation incorporating voices from all corners of the market. Such a mechanism must be carefully built.

These Standards form also a technical yardstick with legal -- right to market entry -- teeth. Technical documents and legal Process rarely mix unless both these aspects are carefully considered in their generation. This imposes yet another set of factors in the construction of a standards-making machine. There are many ways, in detail, to address this dilemma; the complete answer awaits discovery -- if, in fact, it can exist.

Network Standards are also important. There is precious little point in permitting terminals sourced from a free market to connect to a network which has no defined 'end' of a stable technical kind; equally, the possibility of network interconnection is hopelessly frustrated when the technical nature of the electrical signals needed to provide such a working interconnection is not known or not consistent across a population of network interconnection points. Moreover, the 'end' of the network must be known, both physically and technically; the 'legal end' of the network is another keystone which will be mentioned later.

A further technical matter is that of network addressing practice. Networks only provide -- and can only provide -- service to terminals because each terminal is assigned a unique address which can be uniquely selected. In the new environment, someone must control the assignment of network port addresses; without this order, the utility of an infrastructure is limited. Numbering in even a network of modest size is a sensitive and technically crucial issue; without an appropriate strategy taking into account today's limitations of installed technology as well as tomorrow's possibilities afforded by new equipment of a more intelligent kind, irreconcilable technical conflict can occur.

And there remains the service provider: one who offers via the network pipeline a service to users. Whether such a service can exist is determined by service descriptions, or operational Standards. These in turn rely in part upon network standards and in another part upon Terminal Equipment Standards which collectively form yet another component in the legal understanding which enables such a provision.

Standards, then, are important -- immensely important -- in the new environment to which the traditional PTT must migrate. Standards are also traditionally written by engineers: not economists, civil servants, or legal counsel, but by engineers. And hence the legal community takes its place.

THE LEGAL DIMENSION

An understanding between two entities to enable each harmoniously to use and to contribute to the resources of the other is a concept as ancient as humanity itself. It finds its viability in the enshrinement of right derived from that understanding and imposed by a system independent of and superior to each: the Law, as commonly manifested by the Judiciary and Process.

In a free market it is reasonable to assume that what is bought is safe with respect to the human condition and is intended to function as described. In the telecommunications world, this means that a telephone terminal -- whether bought from a manufacturer or via a distributor from the local drug store -- is expected by the buyer to work. It is, of course, absurd to suggest that such an item is capable of washing clothes; from that point of view, the telephone will not 'work'.

Here, then, are exposed the first two legal components of telecomms resource management: market entry by terminal equipment suppliers must be controlled in terms of terminal-network interoperation as well as in terms of its technical description of itself.

The former consideration is one linking the manufacturer of the equipment -- and perhaps its design -- to the provider of the network and its design. There is a synergy between the two which must have been achieved: a standard must have been written and consulted. The latter consideration concerns the supplier himself: but must also be carefully controlled by the legal application of (different) technical standards. For example in a world where fax machines are not permitted to be sold on the free market, what is to stop the suppler of a fax machine with a telephone as an integral part thereof entering the market by declaring such a device to be a telephone alone?

A similar situation could be set out with respect to network-borne services. The service provider who requires a particular network access to enable the distribution of his product may specify that access as part of the legal contract of use of the network (and perhaps as a part of an agreement to supply to a customer). Again, reliance is placed upon the same two components: a description of the service-network interoperation and a (perhaps technical) description of the service itself.

The first of these two components relies upon a legal instrument which is itself technical; the second relies on (perhaps generic) application of statutes intended to order the market place: "what you have been told you have bought is what you have bought".

This illustration is intended to show the breadth of legal application to the telecommunications environment -- from common law (in those social structures where common law exists) and general Statutory Law to the legal application of Standards, either of themselves (as in their use for market entry) or by means of other Statutes (as in the case of, say, the provision of a service).

There are other components: an agreement to attach to a network may not specify for what purpose that attachment is made; an agreement to supply a service may sit upon a contract (between still different parties) to use the pipeline which carries the service intended to be supplied.

The interplay between these degrees of legal rigour must be clear, unambiguous, and without hiatus: and this becomes the role of the regulator: the one who says whether an arrangement between the parties in the telecomms environment is binding in Law, and if so, how: whether it is enforceable by Law, and if so, which: whether it is the subject of statute, and if so, which one.

How much easier it is simply to refer all matters to the PTT.

THE REGULATORY DIMENSION

The telecomms Regulator is a friend to all and at the same time a friend to none. He must be technically competent; an economist; a businessman; understand marketing and market forces; and, in this shrinking world, often must be a Diplomat representing his National interest abroad. It is from the Regulator that national strategy of development and use of the infrastructure must come; in an era where the national GDP fraction attributable to telecommunications is a significant part of the whole, his deliberations have also a significant impact on the National Economy: on jobs.

Perhaps a key part of the Regulating function is that of setting up a body independent both of market pressures and of network policy able to determine rationally whether market entry of a given product (either goods or services) can be granted. The reference point must include Standards. The function must be sufficiently aloof from the marketplace to encourage and to sustain unbiased competition, yet close enough to determine whether standards which enable market entry are technically achievable and rational.

A further complication is that of determining whether products seeking market entry conform to the Standards which delineate the market: whether something 'passes the test' is often a function of how that test is done. Furthermore, these activities must be visible and objective in order to permit structured equitable competition.

This is a non-trivial task.

The infrastructure, its technical and commercial management, and its ability to encompass network components which collectively interwork but which are technically and commercially quite separate and distinct is another part of the Regulation jigsaw. Without equitable network competition (achievable perhaps only by equality of geographical scale and user attachment), asymmetry must be used in the Regulation methodologies applied to the various interests. It must be carefully structured to preserve the whole whilst allowing the parts (and hence the whole) to prosper and to grow. The issues range widely, from user cost (tariff structures) to third-party use of private circuits.

These are also non-trivial tasks.

But perhaps the greatest responsibility which sits upon the Regulator's shoulders is that of visualising and implementing the dreams of that to come. The determination of how the National telecomms resource might grow and thereby enable and encourage commerce and industry: the identification of a workable National Strategy.

Technology changes: its role to support and to complement commerce and industry is also changing. And as technology goes, so follows telecommunications. The National telecomms resource, a triangle with corners of network provider, equipment supplier, and service user, must be connected in whole and in part to the Regulator. He not only 'pulls the strings'; he also determines their length and when and how they are pulled.

This is the most non-trivial task of all.

THE RESPONSE OF THE PTT

The environment facing today's PTT is new: for the first time, commercial and technical factors converge to provide pressures from which the PTT can neither hide nor escape. The response requires restructuring on a wide scale, includes the need to build new institutions from blank sheets of paper rather than upon stable foundations, and concerns the definition of complicated and delicate interrelationships within as well as without the marketplace.

There are as many sets of solutions to these problems as there are nations: each set must bear the fingerprint of the society in which it resides, structured to serve the specific needs of that people. Yet there are common threads.

First, the telecommunication resource triangle must be allowed to become two-dimensional: the linear scale with provider of all at one end and user of what is or can be found at the other end is hard to justify, let alone sustain.

Secondly, there must be clear separation between network provider, supply industry, and user: there must be different and distinct regulatory links to all.

Thirdly, there must be mechanisms to encourage market forces: in infrastructure and in terminals and services. Yet market forces uncontrolled exhaust a finite supply and pollute a bounded space, and the telecomms infrastructure is characterised by both. The mechanisms must be assembled with informed caution.

And, finally, there must be a separation of powers, the re-casting of the legal structure which enables those powers, and the development of consensus throughout: those with privilege must be given accountability, those with an interest, a voice.

Truly, a non-trivial task.

The Dynamically Changing Regulatory Climate for Foreign Investment in United States Telecommunications Companies

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1. ABSTRACT

In response to the extraordinary interest in recent years by foreign nationals from the Pacific Rim and other countries in investing in the United States telecommunications industry, this paper identifies and discusses United States statutory and regulatory restrictions on foreign ownership of United States telecommunications facilities, and how best to structure arrangements consistent with that regulatory scheme. While most restrictions are intended to ensure that control of such facilities remains in the hands of United States citizens, certain regulations are intended to provide information and leverage that may help to minimize discrimination against United States common carriers in foreign markets. Recent developments have placed U.S.-owned and foreign-owned international common carriers on a more equal footing in the U.S. market and have also been designed to encourage greater competition in international services and lower, cost-based rates for international services. The article suggests ways of facilitating foreign investments that do not contravene U.S. ownership restrictions, and also notes recent indications that certain agencies of the United States Government may now be reasonably receptive to considering relaxing some or all of these ownership restrictions, at least to the extent of affording reciprocity to citizens of other countries that allow open market entry by United States firms. Given the increasing receptivity of some governmental offices to greater foreign investment and favorable timing for such investment, we suggest various ways of facilitating arrangements between Pacific Rim entities and U.S. telecommunications companies.

2. INCREASED INTEREST BY FOREIGN FIRMS IN ENTRY INTO THE UNITED STATES TELECOMMUNICATIONS MARKET

In the past several years, foreign nationals and firms have become increasingly interested in investing in United States telecommunications companies. For example, British Telecommunications plc ("BT") has recently agreed to acquire a significant interest in MCI Telecommunications Corporation ("MCI") -- the United States' second largest interexchange carrier. Foreign telecommunications administrations from a number of European countries have already or are rumored to be making significant U.S. telecommunications investments. Moreover, private companies, such as Swissair, not primarily known abroad for their communications interests, have also invested in U.S. telecommunications firms. Much interest among non-U.S. companies and foreign governments has also been generated from the Pacific Rim area. The acquisitions of interests in U.S. firms with motion picture studios, such as Sony's acquisition of Columbia Pictures, and Matsushita's acquisition of an interest in MCA, Inc., have made headlines. Also receiving substantial public attention was C. Itoh's and Toshiba's investment in the Time-Warner media conglomerate.

As Rupert Murdoch's much-publicized exchange of Australian for U.S. citizenship to permit U.S. media acquisitions demonstrates, however, the nature and scope of many of these investments is substantially affected by United States laws and regulations restricting ownership of communications firms.(1) Acquiring a significant interest in a United States telecommunications carrier has consequences that are materially different from those of investing in most other U.S. properties, as well as from those of investing in foreign telecommunications industry firms.

Foreign ownership and investment in the operations of a U.S. carrier triggers a wide variety of federal statutes, Federal Communications Commission ("FCC") rules, and other restrictions whose impact largely turns on the nationality of the purchaser and the scope and nature of its operations abroad. Moreover, given various recent regulatory, tax, and international trade developments, this area of the law is undergoing significant change and reexamination both in the U.S. and abroad.

Based on our recent first-hand participation in negotiating and arranging for foreign ownership of U.S. telecommunications properties involving a variety of different nationalities, this article sets forth and comments upon the regulatory scheme affecting U.S. investments by foreign commercial interests and foreign entities, including those from the Pacific Rim. The paper traces the background of the alien ownership restrictions of the 1934 Communications Act, as it applies to radio licensees, satellite and microwave carriers, and broadcasters, and highlights indications that the regulatory environment may become more receptive to at least reciprocal relaxation of current ownership restrictions. Finally, the paper not only identifies many of the significant ownership restrictions, but also discusses a variety of corporate/financial structures and regulatory strategies to mitigate or circumvent the seemingly inflexible statutory restrictions and bans of the 1934 Act and promote arrangements between Pacific Rim investors and U.S. telecommunications firms.

3. RESTRICTIONS ON FOREIGN OWNERSHIP OF TITLE III RADIO LICENSEES

3.1 ORIGIN OF AND OPPORTUNITIES FOR CHANGES IN OWNERSHIP RESTRICTIONS

As a general matter, foreign ownership of firms holding radio licenses (including such authorizations as radio broadcast, microwave, satellite, and cellular licenses) regulated under Title III of the Communications Act(2) is much more restricted than is the ownership of firms holding non-radio authorizations. The ownership of broadcast station licensees is the most heavily scrutinized, and ownership of holders of common carrier authorizations is more restricted than ownership of holders of private carrier authorizations.(3)

The current restrictions are the result of a statutory prohibition included in the Communications Act. The antecedents of these restrictions were included in the Radio Act of 1927,(4) for, following World War I, fear of use of radio in aid of espionage or sabotage by a potential enemy led to imposition of the original restrictions on foreign ownership of radio facilities.(5) Interestingly, this statute, designed to prevent espionage and sabotage during war at a time when communications was in its infancy, and few carriers existed, has been stretched virtually beyond recognition to bar many foreign investments in today's highly competitive high technology concerns, even by the most loyal allies of the U.S. While it is too early to discern the position of the Clinton Administration, whose FCC Chairman Reed E. Hundt has just taken his seat on the Commission, Bush Administration officials and other U.S. regulators gave serious consideration to relaxing these restrictions. Former FCC Chairman Sikes, for example, spoke out against "parochialism" in U.S. and foreign regulatory processes and expressed a commitment to "building international relations among communications policy-makers."(6) Chairman Sikes also stated that "protectionism is self-defeating," and went on to say not only that the statutory ownership restrictions "date back to another technological and commercial era," but also that the FCC and the Bush Administration "strongly support open international investment with very limited national security exceptions."(7) Nonetheless, Chairman Markey of the U.S. House of Representatives' Telecommunications Subcommittee and others have previously recommended expanding the coverage of the statutory alien ownership restriction to encompass cable television and certain other new technologies,(8) and to consider the availability of "national treatment" abroad when evaluating applications to provide international telecommunications services by foreign-affiliated couriers. The first hints of the new Administration's policies may appear in the FCC's decision on the proposed BT investment in MCI.(9)

It therefore continues to be critically important for potential foreign investors not only to continue to be cognizant of the scope of U.S. ownership restrictions, but also to monitor the U.S. regulatory environment closely so that they may identify significant potential changes promptly and consider appropriate responsive actions.

3.2 SCOPE OF OWNERSHIP RESTRICTIONS

Under the current regulatory scheme, the sole absolute restriction on foreign ownership of U.S. radio licensees applies only to foreign governments. Specifically, Section 310(a) of the Communications Act prohibits a foreign government, or its representative, from holding any radio license. This prohibition applies even to a private radio license, and it is the only statutory foreign ownership restriction that does apply to private radio licenses. Thus, in the satellite radio context, the FCC recently scrutinized an applicant's partnership documents to determine under Section 310(a) that foreign government investors had no control of a private satellite system applicant.(10)

The other statutory restrictions, however, do not impose a complete ban on foreign investment in radio licensees, and are inapplicable to interests in private radio licensees. Section 310(b) of the Communications Act prohibits a broadcast, common carrier, or aeronautical en route or aeronautical fixed radio license's (but not a private radio license's) being granted to or held by a corporation (1) having an officer or director who is an alien or a representative of an alien; (2) organized under the laws of a foreign country; or (3) having 20% or more of its stock under foreign ownership or control (that is, owned or voted by one or more aliens or foreign governments, or their representatives, or foreign corporations).

Under a related statutory provision, however, a foreign investor may acquire a somewhat larger interest, so long as it is held indirectly. Under Section 310(b)(3), and subject to the discretion of the FCC, a tiered ownership structure may be utilized to allow this greater indirect foreign ownership. Thus, the FCC may issue licenses to a corporation controlled directly or indirectly by another corporation where non-U.S. citizens comprise less than 25% of the parent company's board of directors, and less than 25% of the parent company's stock is foreign-owned. The parent company may not, however, have an officer who is not a U.S. citizen.

This discretionary indirect ownership "safe harbor" provision has also been applied to insulate certain foreign-owned partnership interests. In such cases, for purposes of analogizing partnership interests to corporate counterparts specified in the statute, general partners are treated as corporate officers, although limited partners may be treated as corporate shareholders if their ability to participate in partnership activities is sufficiently limited under specific Commission standards.(11)

The Section 310 requirements, being statutory, are very strictly applied. Thus, publicly-traded U.S. communications firms must have their stock transfer agents closely monitor levels of foreign holdings. Matsushita's acquisition of MCA, Inc., also illustrates the impact of the statutory restrictions, for the New York City-area television station owned by an MCA subsidiary had to be spun-off prior to the completion of the corporate acquisition to avoid violation of the foreign ownership limitations.

3.3 PERMITTED INVESTMENTS IN COMMON CARRIER AND BROADCAST RADIO LICENSEES

The potential foreign investor does, however, have a number of avenues for investing in U.S. firms holding radio licenses. With respect to broadcast or common carrier firms, as suggested above, a two-tiered corporate structure is the most common investment vehicle for increasing foreign participation. Frequently, a U.S.-incorporated holding company is formed to be the parent of the license-holding operating subsidiary to ensure that there is at least one corporate tier between the foreign ownership interests and the telecommunications licensee. Because the foreign ownership interest in the licensee's stock (voting and non-voting) is indirect, it may reach the 25% level, and non-U.S. citizens may hold 25% of the seats on the board of directors of the holding company parent firm.

In some cases, it may be possible to obtain a waiver of this ruling from the FCC if a higher level of foreign investment is desired. For example, in one recent case, the FCC found that an indirect interest of 26.6% represented a de minimis extension above the benchmark, although it deferred action on the applicant's request to be permitted to have indirect alien ownership of 49.9%.(12) Very recently, however, the Commission approved acquisition by Canadians of a 59% indirect interest in a common carrier licensee when 75% of the licensee's directors were U.S. citizens.(13) Thus, the FCC may be more receptive to approving higher foreign indirect interests than it has been in the past, particularly in cases involving a common carrier facility and an applicant from a company with a long history of friendly relations with the U.S.

In ruling in these cases, the FCC will consider a number of different factors, including:

1. Whether the foreign parent company is publicly held;
2. Whether the ownership interests are held by foreign governments;
3. The percentage of alien officers and directors;
4. Whether the licensees are common carrier rather than broadcast licensees, and thus do not have an opportunity to initiate or control transmission content;
5. The degree of the licensee firm's need for working capital;
6. Whether the investment facilitates participation by the U.S. firm in ventures abroad or assists it in obtaining foreign operating agreements;
7. The relationship of the foreign owner's domiciliary country with the United States; and
8. The potential impact of the proposed transaction on the industry involved, including antitrust and competitive implications and the need for capital or technology for new services.

It should also be noted that there are generally no statutory limitations on foreign investments if they take the form of loans and debt securities. Traditionally, the FCC has not recognized even warrants or convertible debentures as equity securities until the conversion rights are exercised.

Another approach that may be utilized to permit increased levels of foreign investment is to review the nature of the firm's business activities. If what is critical to the continuation of its activities is not necessarily control of the radio licensed facilities, but merely the opportunity to obtain the radio-based services they afford, it may be possible to spin off the licenses to a separate firm that has no alien ownership in an arms-length transaction.(14) Under certain carefully designed conditions, the newly-formed licensee firm would provide services (such as transmission capacity) to the now license-free foreign-owned firm. For example, if foreign investors wish to acquire a facilities-based microwave interexchange carrier, they could instead operate the business as a reseller of capacity of a new firm established on a bona fide arms-length basis that is the assignee of the microwave licenses.(15)

Another alternative to consider is whether the firm could essentially carry on its business activities as a private, rather than a common, carrier.(16) Aside from limited tariff filing requirements, the distinctions between common carrier and private carrier activities have become blurred by the FCC's limited federal regulation of non-dominant domestic common carriers. Yet there are virtually no limits on foreign holding of private radio licenses except those applicable to foreign governments.(17)

3.4 PERMITTED INVESTMENTS IN PRIVATE RADIO LICENSEES

There are fewer restrictions on foreign ownership of private radio licensees, because they are subject only to the provisions of Section 310(a). This provision only precludes issuance of licenses to foreign governments and their representatives, although it applies to both domestic and international facilities. Private carriers that carry third party traffic may operate microwave, satellite, and transoceanic cable facilities. For example, the PTAT private transatlantic fiber optic cable, which offers capacity to both carriers and end-users, was structured as a private carrier.(18) PanAmSat has initiated private satellite service as a separate satellite system operator.(19) Various microwave service providers offer end users domestic private microwave services via facilities licensed in the domestic Private Operational Fixed Service ("POFS").(20) Where facilities are to be utilized for the exclusive use of the licensee, even 100% foreign ownership may be authorized, as indicated by the Reuters decision, involving foreign ownership and operation of an Intelsat Business Service earth station used to transmit news reports in furtherance of Reuters' business of providing news stories to customers. Recently, the FCC has confirmed that private carrier earth station facilities may be used on a for-profit basis to serve third parties. Last May, Brightstar, a British firm, was authorized to operate a private carrier earth station for international television program distribution to countries outside the U.S.(21)

It should be noted, however, that private and common carrier facilities are not necessarily completely interchangeable. For example, POFS facilities may be interconnected with the public switched telephone network ("PSTN") only for transmission of business-related communications.(22) With respect to separate satellite systems, at this time only limited interconnection with the public switched network ("PSN") is permitted.(23)

4. DOMINANT CARRIER TREATMENT OF CERTAIN FOREIGN-OWNED TITLE II INTERNATIONAL COMMON CARRIERS

In addition to the statutory restrictions on the ownership of radio licensees, there are also certain regulatory requirements imposed by the FCC as a matter of policy that are applicable only to certain foreign-owned international common carriers, whether or not they hold radio licenses. Unlike most foreign telecommunications markets, the United States common carrier market is open to participation by foreign-owned carriers, whether they are facilities-based carriers or resellers.(24) As a result of recent policy changes,(25) with respect to their domestic services, foreign-owned interexchange carriers are treated no differently from their U.S.-owned competitors, and are largely free of federal regulation other than tariff filing requirements.(26)

Both U.S. or foreign-owned interexchange carriers that offer international services are, however, treated as dominant carriers with respect to their international services on particular routes as to which they or their affiliates have market power through the control of bottleneck facilities in the foreign market that would allow them to discriminate against other U.S. carriers serving that route. Significantly, such dominant carriers are now subject to additional regulation for their international services only on those routes where they are deemed to have the opportunity and ability to exercise market power. This new policy represents a substantial shift from the previous FCC policy that regulated all foreign-owned carriers as dominant, generally on all routes, and which distinguished between U.S. and foreign-owned carriers on the basis of foreign ownership alone. It thus gives greater encouragement to foreign investment in U.S. international carriers.

The foreign ownership issue most often arises in the context of an application for authority under Section 214 of the Communications Act (a "Section 214 application") to provide international services on a facilities-based or resale basis, or to obtain a transfer of control of a company already holding a Section 214 international authorization. In order to promote reciprocal treatment of U.S. carriers abroad, the Commission will condition the grant of the requested authority on dominant carrier classification of the carrier with respect to its international services on a particular route as to which the applicant or its affiliates has market power. Significantly, the FCC has applied dominant carrier regulation on the U.S.-Guyana route to a U.S.-owned company. Atlantic Tele-Network, Inc., a General Telephone subsidiary affiliated with the dominant telecommunications service provider in Guyana.(27)

Under the new policy, the FCC will presumptively declare to be non-dominant international carriers unaffiliated with foreign international carriers or carriers proposing to resell the switched services of U.S. facilities-based carriers with which they are not affiliated. Similarly, any carrier whose foreign affiliate is a monopoly provider or controls bottleneck facilities in its "home" market will presumptively be made subject to dominant carrier regulation for service between the U.S. and the country(ies) in which it or its affiliate controls bottleneck facilities. However, in the event that the carrier shows that the regulatory system in the country in which the bottleneck facilities are located precludes the exercise of the power to discriminate against other U.S. carriers on that route, the FCC will afford non-dominant treatment to the U.S. carrier. Carriers with non-dominant foreign affiliates will have their applications for non-dominant treatment scrutinized, but will generally be afforded non-dominant status upon a reasonable showing of non-discrimination.(28)

Moreover, the degree of adverse impact on market entry by carriers with foreign affiliates caused by such route-specific dominant carrier regulation is mitigated by the fact that the consequences of dominant carrier classification, while imposing administrative and other not inconsequential costs on carriers and some loss of flexibility in changing service offerings, are not so burdensome as totally to foreclose a carrier from competing effectively in the U.S. market. The additional requirements include:

1. Tariffs for international services on the dominant route must be filed on 45 days' notice.

2. Tariffs for international services on the dominant route must be accompanied by economic and cost support data.

3. Section 214 approval must be received from the FCC not only for initiation of service to a country (a requirement also applicable to non-dominant carriers) but also for modification of facilities or increases in circuits to a country as to which a carrier is deemed a dominant carrier.

4. Carriers found to be dominant must file both their own and their parent or affiliated firms' operating agreements affecting traffic and revenue flows to or from the United States.

5. Carriers must file quarterly traffic and revenue reports with respect to their international services on the routes as to which they are deemed dominant.(29)

5. ACCOUNTING RATE REDUCTION AND PRIVATE LINE RESALE

A major issue for U.S. policy-makers has been the significant U.S. balance of payments deficit resulting from the imbalance in traffic settlements for international telecommunications services between the U.S. and other countries. Because rates are almost always lower for calls originating in the U.S., and because there are substantially more outbound calls from the U.S. to almost all other countries, there is a substantial U.S. net settlements outpayment. To reduce this, the FCC has actively tried in international fora to encourage other countries to bring their international rates closer to actual costs (to promote increased calling from third countries to the U.S. and to reduce the disparity between the rates for U.S.-originated and U.S.-terminated calls), thus lowering the U.S. settlements outpayment.(30) The FCC has also been conducting an ongoing review of accounting rates, and has required larger U.S. carriers to report on this status of negotiations with their foreign correspondents to reduce the rates used for settlements. The FCC has also issued guidelines that would set accounting rates between U.S. and Europe at $0.23/-minute - $0.39/minute, and between the U.S. and Asia, Latin America, Africa, and the rest of the world at $0.39/minute - $0.60/minute -- levels achieved to date in few instances.(31)

The FCC has also acted to open the U.S. market to increased competition when the effect is to reciprocate for increased competition abroad. Thus, in late 1992, the FCC authorized U.S. carriers to resell international private line facilities interconnected with the PSNs at both ends of a circuit for the offering of switched services.(32) Such "private line resale" is permitted only with respect to those countries which the FCC has determined afford "equivalent opportunities" to U.S.-owned carriers for such resale. (Foreign regulatory schemes do not need to mirror the U.S. system, but they do need to provide relatively open market entry at least for international resale carriers.) To date, the FCC has made the necessary "equivalent opportunities" finding only with respect to service to Canada,(33) but applications currently pending seek to provide private line resale to the U.S., Sweden, and Australia.(34)

These policy developments demonstrate that U.S. policymakers will be receptive to requests for additional opportunities for foreign-owned carriers to compete in the U.S. international switched services market if their home countries will entertain similar competitive entry.(35) U.S. policymakers have been resistent, however, to further liberalizing entry to the competitive U.S. market when carriers' home markets remain more or less closed or the settlements deficit could be worsened as a consequence.

6. SUBMARINE CABLE LANDING LICENSES

Like the use of dominant carrier regulation of foreign-owned international interexchange carriers, the submarine cable landing license law is now utilized chiefly to secure leverage to promote U.S. interests abroad. Initially, however, like the statutory restrictions on radio license holding, it was enacted after World War I largely as a result of concern arising from German and U.K. dominance in the ownership of transatlantic cables.

Pursuant to the Submarine Cable Act of 1921, 47 U.S.C. § 34, the FCC, in coordination with the U.S. Department of State, is authorized to grant licenses for the landing of submarine telecommunications cables in the United States. While traditionally these cables have been owned by consortia of common carriers and capacity has been made available on a common carrier basis, in recent years several private fiber optic submarine cable systems have been established, including the PTAT-1 transatlantic cable and the North Pacific Cable ("NPC") transpacific cable.(36)

The statute specifically provides that licenses may be granted and withheld based on determinations as to the relative involvement of U.S. and foreign interests in the project and determinations of whether U.S. interests are receiving sufficiently reciprocal treatment by the foreign governments involved. While the FCC does not necessarily require that U.S. interests hold a half-interest in the project as a whole and be treated exactly in the same manner as their foreign partners, it will look to several factors to determine whether the benefits to the U.S. participants are sufficient. These factors include: 1) The proportion of U.S. to non-U.S. interests in the project; 2) the fairness of the contract procedures and opportunities for U.S. contractors to participate in the project; 3) the relative

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importance of the project to the public; and 4) the opportunities the project affords for U.S. investment abroad, including the degree of reciprocity shown U.S. interests abroad.

There are no specific standards to be applied in this analysis, so the determination may be quite fact-specific and may be affected by particular international policy concerns at the time the decision is made.

Ideally, from the FCC's perspective, the U.S. interests would own the entire U.S. "backhaul" network to connect the cable with carrier points of presence ("POPs"), would own one-half of the undersea cable system, and would receive one-half of the contracts awarded to construct the project. Recognizing that requiring complete equivalence is not always practical, however, the FCC will generally be satisfied if the first two conditions are met, U.S. interests receive reasonably reciprocal treatment abroad, and the contracting process ensures that U.S. firms have a real opportunity to obtain a reasonable proportion of the construction and maintenance contracts for the project.

Insofar as a project may represent one of the first opportunities for significant U.S. investment in a particular foreign telecommunications market, the FCC may also relax its policy with respect to the degree of reciprocity shown U.S. interests abroad. Thus, the FCC has interpreted the Submarine Cable Act in several instances to mitigate foreign ownership of several Pacific Rim cables. On the other hand, the FCC, because of looming international trade considerations and Congressional pressure, has been more vigorously scrutinizing and at least threatening to enforce more vigorously these provisions, at least as to certain trading partners. It has also extended the consideration of reciprocity issues beyond the submarine cable context to other licensing situations, as in the implementation of the requirement of an "equivalent opportunities" determination prior to authorizing private line resale to a particular country.

7. CONCLUSION: TAKING ADVANTAGE OF CHANGING REGULATORY ATTITUDES TOWARD AND OPPORTUNITIES FOR FOREIGN INVESTMENT

There are numerous opportunities now for substantial foreign investment in U.S. telecommunications firms, and there are signs that the opportunity may exist for foreign firms to acquire even larger interests in U.S. firms in the future through the FCC's recent relaxation of certain regulatory policies and possible Congressional relaxation of current statutory restrictions. Foreign nationals cannot make U.S. telecommunications investments, however, without specifically considering the current U.S. restrictions on and policies affecting foreign investment in a particular industry segment. By careful planning, investors can structure proposed investments so as to avoid any preclusive restrictions, can facilitate timely grants of necessary approvals, and can minimize the degree of regulation to which a business may be subject.

Where U.S. policies are based on the availability of reciprocal treatment of U.S. interests abroad, careful review of national policies in the "home" country, and approaches to promoting reciprocal treatment of U.S. interests there, may also be helpful in bringing a contemplated U.S. investment to a successful consummation. Additionally, potential investors can work in the U.S. to promote the continued openness of various FCC and administration officials to recommending legislation that would give them the discretion to relax the statutory requirements, at least in response to a reciprocal opening of foreign markets to U.S. investors. Due in part to increasing pressure from U.S. carriers seeking access to increased levels of foreign investment capital, there is a growing sentiment that foreign investors from a nation whose telecommunications infrastructure is relatively open to competition from U.S. market entrants (e.g., the United Kingdom) should be relieved from this statutory bar, particularly as U.S. carriers seeking entry in foreign markets are met with the response that concessions abroad may be dependent on an open entry policy at home. Thus, this is an opportune time for foreign investors to consider entry and increased investment in the U.S. telecommunications market.

1. There are, however, a substantial number of important types of investments in United States communications firms that do not implicate any foreign ownership restrictions. For example, there are at this time no restrictions on foreign ownership of U.S. cable television systems, movie studios, consulting services, information services providers, computer services, or equipment manufacturers. In the telecommunications area, there are no restrictions on ownership of domestic interexchange carriers ("IXC") or resellers, local exchange carriers ("LECs"), or competitive access service providers ("CAPs"), provided that they do not hold radio authorizations. Thus, in addition to common carrier firms such as Cable & Wireless, equipment manufacturers such as Fujitsu and Siemens have active U.S. affiliates. (We note, however, that Public Law 100-418, 102 Stat. 1107 (1988), popularly known as the Exon-Florio Act, does allow the President to delay, prohibit, or require unwinding of any investment in any U.S. firm, in any industry, that is deemed to be a threat to U.S. security interests. To date, there has been formal action in only one situation, and that did not involve the communications industry.)

2. 47 U.S.C. § 301 et seq. (1988). Should the new Personal Communications Service ("PCS") also be declared a common carrier service, the same alien ownership restrictions applicable to cellular systems would apply to PCS.

3. Private radio authorizations may be obtained for operation of such facilities as microwave and satellite systems, as well as for use by special types of users, such as motion picture companies, power companies, and emergency services. In a number of services, authorizations may allow facilities to be

shared with other eligible users, even on a for-profit basis. See, e.g., Licensing Under Title III of the Communications Act of 1934, as amended, of Non-Common Carrier Transmit/Receive Earth Stations Operating with the INTELSAT Global Communications Satellite System, FCC 93-93 (released Mar. 5, 1993) ("Brightstar").

4. Radio Act of 1927, Ch. 169, 44 Stat. 1162, 47 U.S.C.A. 81 et seq. (repealed 1934).

5. See, e.g., Remarks of Chairman Alfred C. Sikes, "Globalization of the Telecommunications Market: Foreign Investment Issues," before the European Institute's Conference on "European Investment in the United States: Unity and Fragmentation in the American Market" (Sept. 23, 1991) ("Sikes' Sept. 23 Speech") at 4-5; Remarks of Janice Obuchowski, "Media Globalization From Prophecy to Fact of Life," (Sept. 13, 1991) at 7; see also, Continental Cellular, FCC 91-355 (released Nov. 20, 1991) at 3 (citing 68 Cong. Rec. 3037 (1927)). The communications industry is not unique in having such statutory ownership restrictions. See 16 U.S.C. § 797 (e) (barring dam construction license grants by the Federal Power Commission to aliens and alien-controlled entities); 33 U.S.C. §§ 1502 (5), 1503 (g) (limiting ownership and operation of deep water ports to U.S. citizens and corporations); 42 U.S.C. §§ 2133, 2134 (barring the issuance of nuclear power plant licenses by the Nuclear Regulatory Commission to aliens, alien-controlled corporations, and foreign governments); 30 U.S.C. § 1015 (geothermal production leases on federal lands authorized only for U.S. citizens, corporations, and governmental entities); 10 U.S.C. § 2272 (restricting awards of aeronautical design contracts to corporations with less than 25 per cent alien ownership).

6. Remarks of Alfred C. Sikes before the Columbia University Business Schools Institute for Tele-Information, Special Evening Symposium on International Regulatory Agenda for the 1990s (Nov. 4, 1991).

7. See Sikes' Sept. 23 Speech; FCC News, Mimeo No. 14896 (Sept. 23, 1991); see also "Obuchowski Calls Ownership Restrictions Solution in Search of a Problem," Comm. Daily, Vol. II, No. 179 (Sept. 16, 1991) at 1, reporting on the recommendation of the Bush Administration's Administrator of the National Telecommunications and Information Administration ("NTIA") that the U.S. consider easing restrictions even on foreign ownership of U.S. broadcast outlets.

8. "No Must-Carry Deal; Markey's Program Access Provisions Draw Cable Opposition," Comm. Daily, Vol. 10, No. 123 (June 26, 1990) at 1. More recently, on November 19, 1993, Chairman Markey introduced legislation that would require consideration of whether U.S. firms receive national treatment in a given country when the FCC acts on an application from a carrier with affiliates in that country that seeks to enter or expand its activities in the U.S. telecommunications market for international services. See H.R. 3565 (103d Cong., 1st Sess.), the proposed "Fair Trade in Services Act of 1993."

9. Chairman Markey has also asked the FCC to determine whether the proposed investment in MCI by BT involves Section 310(b) because, for example, of BT's power to approve certain MCI business arrangements. "FCC Scrutinizing Hand of British Telecom Control in Deal with MCI," Washington Telecom Week No. 36 at 1, 15-16 (Sept. 10, 1993).

10. See Orion Satellite Corporation, FCC 90-241, File No. CSS-83-002-P-(M).

11. See Wilner & Scheiner, 103 FCC 2d 511 (1985), reconsidered in part, 1 FCC Rcd. 12 (1986) (holding that the alien ownership prohibition "applies equally to all financial interests in all business forms of licensees"); Reexamination of the Commission's Rules and Policies Regarding the Attribution of Ownership Interests in Broadcast, Cable Television and Newspaper Entities, 97 FCC 2d 997, 1009 (1984), reconsidered in part, 58 Rad. Reg. (P&F) 2d 604 (1985), further reconsidered, 1 FCC Rcd. 802 (1986) (collectively, "Attribution Orders"). In Wilner & Scheiner, the Commission stated that it would look to the standards for insulation of limited partners from attribution of ownership in determining whether a limited partner that was not a U.S. citizen was sufficiently insulated from participation in partnership activities to warrant ignoring the interest for purposes of the alien ownership restrictions. Recently, in Continental Cellular, FCC 91-355 (released Nov. 20, 1991) ("Cellular Foreign Ownership Decision"), the Commission relied on the Wilner and Scheiner decisions and upheld its staff's dismissal of 21 applications for cellular radio authorizations. (In 20 cases, at least one of the general partners was not a United States citizen, and, in one case, a limited partner who was not a U.S. citizen was found to be insufficiently insulated from partnership activities.) The FCC also held that the alien ownership defect could not be cured with a minor amendment, citing 47 C.F.R. § 22.918(b), although this defect may be cured during an "amendment-as-of-right" period with respect to radio broadcast applications. The Cellular Foreign Ownership Decision included a succinct summary of the insulation standards of the Attribution Orders:

> The Attribution Orders required that in order for a limited partner's interest not to be attributed the partnership agreement must state, in express terms, that the exempt limited partner is prohibited from becoming actively involved in the management or operation of the communications business

> of the partnership. Moreover, the exempt limited partner must not be allowed to vote for the removal of a general partner except for cause. Additionally, the limited partnership agreement must bar the exempted limited partner from serving, in any material capacity, as an independent contractor or agent. Finally, the exempt limited partner cannot act as an employee of the limited partnership if his or her functions, directly or indirectly, relate to the communications enterprises of the company.

Id. at n.22. The FCC also noted that a limited partner cannot use a private contract, rather than the terms of the partnership agreement, to insulate itself from management and thus secure an exemption from attribution. Id. at 7 n.23. The alien ownership restrictions have also been applied in cases involving other unincorporated interests, including mutual insurance company policyholders, Farragut Television Corp., 4 Rad. Reg. (P&F) 2d 350 (1965-); members of a church, Kansas City Broadcasting Co., 5 Rad. Reg. (P&F) 1057 (1952); beneficial owners of irrevocable trust interests, Prime Media Broadcasting, Inc., FCC 88-218 (Jul. 12, 1988); and members of a labor union, Chicagoland TV Co., 4 Rad. Reg. (P&F) 2d 747 (1965).

12. See IDB Communications Group, Inc., 6 FCC Rcd. 4652 (1991).

13. Teleport Transmission Co., FCC 93-990 (Chief, Com. Car. Bur. - May 4, 1993).

14. The Commission is likely to scrutinize the transaction to ensure that the spin-off is in fact an arms' length transaction, and that the foreign owners do not gain de facto or other control of the new firm. See, e.g., Satellite Transmission and Reception Specialist Co., DA 90-927 (C.C. Bur. Jul. 13, 1990) ("STARS") (transaction initially disapproved as not being arms' length, but subsequent spin-off found to be acceptable and application for Section 214 authorization by the now-foreign owned firm approved). See also Licensee Limited Partnership, 5 FCC Rcd. 1673 (1990-); Com Systems, Inc., 5 FCC Rcd. 696 (1990).

15. To the extent that domestic microwave facilities are involved, and the new reseller does not offer international services, it would be regulated in the same manner as any other domestically-owned reseller. The Commission has adopted a policy of regulatory forbearance in most areas with respect to domestic resellers. See Competitive Carrier Service Docket (CC Docket No. 79-252), initiated by Notice of Inquiry and Proposed Rulemaking, 77 FCC 2d 308 (1979); concluded by Sixth Report and Order, 99 FCC 2d 1020 (1985), rev'd sub nom. MCI Telecommunications Corp. v. FCC, 765 F.2d 1186 (D.C. Cir. 1985). The exception is minimal tariff regulation of nondominant domestic carriers. See Memorandum Opinion and Order, Tariff Filing Requirements for Nondominant Carriers, CC Docket No. 93-36, FCC 93-401 (released Aug. 18, 1993); AT&T v. FCC, 978 F.2d 727 (D.C. Cir. 1992), cert. denied, 61 U.S.L.W. 3853 (June 21, 1993).

16. Private radio licenses may be issued to non-governmental foreign entities. Thus, Reuters obtained a private satellite system authorization to feed news reports to its earth stations at customer locations. Reuters Information Services, Inc., DA 89-899, File No. CSG-89-088-A (C.C. Bur. Aug. 3, 1989); see also Brightstar, supra, n.3.

17. In structuring investments by foreign firms in U.S. radio licensees, it is also necessary to consider the international and domestic tax consequences of alternative forms of business organizations. With careful planning and advance consultation with regulators, it can be possible to structure an arrangement that complies with alien ownership restrictions while minimizing adverse tax consequences and ensuring adequate protection for the minority foreign investor.

18. See Cable Landing Licenses, File Nos. I-SC-L-84-002 and I-S-C-L-84-003, Mimeo No. tik, Limited, 100 FCC 2d 1033 (1985) ("Tel-Optik").

19. Establishment of Satellite Systems Providing International Communications, 101 FCC 2d 1046 (1985), on recon., 61 Rad. Reg. (P&F) 2d 649, on further recon., 1 FCC Rcd. 439 (1986).

20. See 47 C.F.R. § 94.1 et seq. Pursuant to the FCC's rules, POFS licensees may make their facilities available on a shared, and for-profit, basis to other users. 47 C.F.R. § 94.17.

21. Brightstar, supra, n.3.

22. See 47 C.F.R. §§ 94.13, 94.9.

23. See International Satellite Systems (Permissible Separate System Services), 70 Rad. Reg. (P&F) 2d 843 (1992).

24. Carriers holding radio authorizations are also subject to the Title III foreign ownership limitations described in Section 3 above. Under prior U.S. policy, certain foreign-owned U.S. international carriers were subject to dominant carrier regulations as a result of their foreign ownership alone.

25. See Regulation of International Common Carrier Services, Report and Order, CC Docket No. 91-360, 7 FCC Rcd. 7331, 7331-32 (1992) (imposing dominant carrier regulation only "in those instances where there is a substantial

possibility of anticompetitive effects on the U.S. international service market"). The new policy was adopted as a result of a Cable & Wireless petition filed in December 1990 requesting initiation of an FCC rulemaking proceeding seeking to have the FCC relax and identify with specificity the criteria for subjecting U.S. carriers with foreign ownership to dominant carrier regulation. The petition argued that, at most, such regulation should be imposed only with respect to the carrier's "home" country, and only if the home country discriminates in some way against U.S.-owned carriers. *See Cable and Wireless Communications, Inc.*, Petition for Rulemaking (RM-7578, Dec. 3, 1990) (Public Notice Dec. 12, 1990, Report 1832).

26. *See Memorandum Opinion and Order, Tariff Filing Requirements for Nondominant Carriers*, CC Docket No. 93-36, FCC 93-401 (released Aug. 18, 1993); *AT&T v. FCC*, 978 F.2d 727 (D.C. Cir. 1992), *cert. denied*, 61 U.S.L.W. 3853 (June 21, 1993).

27. *Atlantic Tele-Network, Inc.*, Order on Review, FCC 93-342 (released July 14, 1993) (File No. I-T-C-90-153).

28. *See* 47 C.F.R. § 63.10 of the Commission's Rules. All regulatory presumptions are rebuttable. The Commission has also recently streamlined some of its Section 214 application processing procedures in the wake of foreign government criticism of attendant delays. *See* 47 C.F.R. § 63.12, which was recently revised to provide for automatic grant of certain unopposed applications after expiration of a 45-day public notice period.

29. *fONOROLA Corporation* (File No. I-T-C-91-103) and *EMI Communications Corporation* (File No. I-T-C-91-050), Memorandum Opinion, Order and Certification, 7 FCC Rcd. 7312, 7316-17 (1992) (*petition for reconsideration pending*); 47 C.F.R. § 61.38; 47 C.F.R. § 61.58.

30. American Telephone and Telegraph Company has been a proponent of efforts to reduce the settlements deficit, but it has been reluctant to quantify the contributions of its "USA Direct" and other carriers' "country-direct" calling services to the settlements deficit. It should be noted also that the U.S. policy of promoting cost-based rates is in conflict with policies of both developing and industrialized countries that subsidize lower domestic calling rates (and, often, non-telecommunications services) by revenues from above-cost international telecommunications services.

31. *Second Report and Order and Second Further Notice of Proposed Rulemaking*, FCC 92-496, CC Docket No. 90-337 (released Nov. 27, 1992).

32. *Regulation of International Accounting Rates*, First Report and Order, CC Docket No. 90-337, Phase II, 7 FCC Rcd. 559 (1992), *recon. granted in part, denied in part*, 71 Rad. Reg. (P&F) 2d 862, FCC 92-517 (Nov. 27, 1992) ("Resale Order").

33. *fONOROLA Corporation* (File No. I-T-C-91-103) and *EMI Communications Corporation* (File No. I-T-C-91-050), Memorandum Opinion, Order and Certification, 7 FCC Rcd. 7312 (1992) (*petition for reconsideration pending*).

34. Several applications also request authority to resell private lines to the U.K. interconnected at only one end with the PSN, a service authorized in the U.K, but not yet in the U.S. There are no "equivalent opportunity" requirements for the resale of private line services for private line services. It should also be noted that various entrepreneurs, including several serving the Pacific Rim, have implemented "call-back" services permitting carriers to utilize U.S. facilities for international calling. The legality of such systems has not been established, and is currently under review by the FCC.

35. In undertaking the review of the international dominant carrier policy, the Commission was motivated by "the progress that has been made to date by U.S. carriers in obtaining operating agreements, [the] desire to reduce regulation where the public interest permits, and [the] concomitant goal of encouraging competitive entry in foreign markets." *Regulation of International Common Carrier Services*, Report and Order, CC Docket No. 91-360, 7 FCC Rcd. 7331, 7331-32 (1992).

36. *See Tel-Optik; see also Pacific Telecom Cable, Inc.*, 4 FCC Rcd. 8061 (1989). Upon receipt of Section 214 approval from the FCC, common carriers may acquire and utilize capacity on private cables.

TECHNOLOGY CONVERGENCE AND IMPLICATIONS FOR A NATIONAL BROADCASTER

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Summary

Major changes to broadcasting associated with technology convergence including globalisation, multimedia and interactive television present special challenges to national broadcasters such as the ABC. The charter and funding arrangements for national broadcasters are different from commercial broadcasters, leading to a different approach to participating in emerging video and audio information and entertainment services. The ABC has actively sought to restructure its business to better position itself to move into emerging service and technology areas. A commitment to efficiency and innovation is a key component of the ABC's technology strategy.

BACKGROUND

The Australian Broadcasting Corporation (ABC) is one of the world's largest national broadcasters. It provides a network of television and radio services throughout Australia employing around 5,500 staff. Its broadcasts carry no advertising. The ABC has undergone major changes over the last 5 to 10 years to better position itself to participate in the rapidly changing broadcasting environment.

In Australia, this period has seen large changes to all sectors of broadcasting. A totally new regulatory environment has been created for both broadcasting and telecommunications, with the new arrangements based more upon the regulation of services than the technology.

Satellite delivered Pay-TV services are due to start about the end of 1994. This has been accompanied by the development of alternative service delivery proposals using cable, MDS and more recently, ADSL. At the same time there have been major ownership changes for commercial television and radio. Many stations have only recently recovered from severe financial difficulties associated with the recent economic downturn.

Along with the rest of the world, the Asian Pacific region is experiencing a communications revolution, driven by the emergence of several new technologies:

- More sophisticated and powerful international satellites.
- Cable and fibre optics.
- Digital compression.
- Convergence of computers, telecommunications, broadcasting, consumer electronics and the print media.

This is the environment of the rest of this decade.

POSITIONING

Over recent years the ABC has sought to position itself to be a participant in both new and developing video and audio services. This has been a positive objective, and one which has taken considerable energy and purpose to achieve. In following this path the ABC has sought to be an innovator and to travel close to the leading edge of technology. The ABC believes that national broadcasters must ''keep up with the game' as this is a key strategy in avoiding marginalisation.

Marginalisation is an area of strategic concern to the ABC. Over the remainder of this decade, free-to-air broadcasting is likely to be challenged by the rapid development of alternative video and audio delivery technologies. While no one can be sure about the impact of multimedia, it is expected that it will progressively eat into traditional free-to-air television markets.

However, there is likely to continue to be a strong place for free-to-air broadcasters as providers of local information and entertainment. There will also be an ongoing need to provide broadcasting services to those people who for various reasons choose not to access subscription or international video and audio services.

Radio will also be affected by digital technology and convergence, but with a somewhat different impact. That's because the majority of radio listening is done in portable or vehicular environments, while in the home it often involves portable receivers. Radio's strengths are its immediacy and its pervasiveness. For many people, radio is a friend and a personal companion. Wireless delivery of free-to-air audio services still appears to have a reasonably bright future.

Participating in emerging service developments and being innovative presents special challenges for national broadcasters such as the ABC. The ABC is dependent upon the Government for much of its funding while its charter obliges the organisation to think very carefully about the way it should embrace new trends in video and audio services and technology.

In recent years the ABC has managed to increase and extend its range of services in an environment of shrinking 'real' levels of Governments funding. This has led to a significant improvement in the efficient management of resources while also encouraging the further development of independent sources of income.

The technical convergence between several technologies is now leading to business convergence. This has manifested itself during 1993 through a series of multi billion dollar alliances, stock acquisitions and buy outs. These arrangements are primarily concerned with forming linkages between sources of media material, service providers, distribution and delivery to homes. These arrangements are also attractive to the ABC and offer a range of possibilities. But it is important to be mindful of what is gained and what is given away in forming these relationships. Ideally the synergy of the relationship provides an equal net gain to all parties.

Over the coming decade, the communications environment will continue to become increasingly fragmented. The ABC's contribution to national identity and the development of Australia will become even more crucial.

MEETING THE CHALLENGE

The ABC has used the last 5 to 10 years to progressively position itself to participate in future audio and video technologies and to accommodate the outcomes of convergence. The changes over this period have been important in meeting both current challenges and preparing for the future. These include:

- Labour reform, which have achieved more efficient and flexible work practices and employment arrangements, and include broadbanding of structures and multi-skilling.
- The restructuring of virtually all resource usage through a mixture of program production costing, internal "user pays' business units and outsourcing of selected services.
- Introduction of smaller and flatter management structures with improved practices and processes including reduced administration and overheads.
- Rationalisation and consolidation of an extensive property portfolio.
- Negotiation of a series of triennial funding agreements with the Government which allow for the longer term planning made possible by more stable funding.
- Introduction of modern digital technology throughout the organisation, particularly for news reporting and editing, and in the major radio studio centres.
- Restructuring the transmission network to be satellite-fed in 5 time zones, using a system that provides a direct to homes service using dishes as small as 1.2 metres.
- Formation of co-operative alliances, e.g. with the Canadian Broadcasting Corporation (CBC), for sharing news gathering sources on a world-wide basis. The ABC currently has 23 overseas bureaus whose primary role is news gathering for our networks.

Perhaps more importantly during this period, the ABC has strengthened its connection with the audience and remained at the forefront of broadcasting through a number of initiatives including:

- Establishment of an international television service (Australia Television International) using the Palapa B2P satellite, with re-broadcast arrangements in several countries
- Participation as a licence holder in Australia's Pay TV services.
- Extension of one national radio network to all country areas and approved plans to similarly extend another.
- A new national 24-hour news radio service due early in 1994.
- Significantly increasing our share and reach ratings for both television and radio through contemporary, distinctively Australian programming.
- Extending product sales through our Enterprises Division to 18 ABC owned shops and over 130 agencies.
- Increasing revenue raised over the last five years by 183%.
- Increasing the total number of terrestrial transmitters to over 1,000, approximately evenly split between television and radio.

The ABC also operates an extensive overseas shortwave service (Radio Australia) and six orchestras. Our Enterprises Division is Australia's second largest independent music label and an influential Australian publisher.

These are key components of positioning the ABC. We believe we have been successful in staying at the leading edge of broadcasting and are well prepared to provide the audio/visual services future.

DIGITAL TRANSMISSION TECHNOLOGY

In a recent talk in Australia, John Abel, Executive Vice-President of the USA National Association of Broadcasters said the driving force behind virtually every new communications technology was digital technology. But around the world, broadcasting is lagging as there is almost no digital broadcasting. Broadcasting is still dominated by analogue delivery technologies. The digital revolution in broadcasting delivery will happen soon and in a variety of ways we can't even contemplate

Most broadcasters are now going through a most uneasy stage of devising strategies for transitioning to digital television and radio. The technology is mostly here and it's now mainly a matter of timing and business decisions. For many countries, satellite and

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cable may be the first successes in digital television.

But in the USA, recent Federal Communications Commission (FCC) decisions may lead to a relatively early transition to digital HDTV. One of the driving forces behind this change is that digital television will occupy less spectrum than analogue. The huge demand for UHF and VHF spectrum for mobile service makes sale of this relinquished spectrum highly attractive.

The FCC has ruled that once an HDTV standard has been determined, broadcasters will have 3 years to decide whether to convert, and if so must do so within a further three years. After a maximum of 15 years simulcasting, the present 6 MHz VHF television channels are to be relinquished.

This decision has caused broadcasters throughout the world to more actively consider their conversion options for digital television, be it for normal TV, HDTV or an intermediate option.

ABC TECHNOLOGIES

The ABC operates one of the world's largest broadcasting networks to serve its domestic audience. The vast majority of our island continent is sparsely populated, yet it is important to provide broadcasting services with extensive local input and in multiple time zones. Because of our specialised broadcasting needs, the ABC has funded its own technology research unit for many years.

A large range of technology developments have been produced over the last few decades. However, several challenges in the late 80s relating to the extension of our radio networks pushed the ABC into a highly innovative and marketable range of digital audio products. Our initial objective was to automate the delay of radio programs across different time zones. In Australia there are three time zones through most of the year but up to five during the summer months. To overcome this problem, our Technology Research and Development Group manufactured digital delay systems with delays of up to several hours, based on computer technology.

These delay systems have worked extremely reliably and have been sold to other broadcasters. But more importantly, the same technology was then extended to develop our D-Cart product. D-Cart is a digital audio storage system primarily designed to replace reel-to-reel and cartridge tape units. It is now perhaps the world's most sophisticated real time, multi-user audio editing and storage product. It is being manufactured in Australia with over 50 systems having been sold world wide.

The ABC's strong commitment to new broadcasting technology and innovation gave us the confidence to make the decision to develop this product and then to market it commercially. Its development is part of a philosophy of positioning the ABC to shape the technology as well as sharing in it.

Follow on products based on extension of this technology are now well advanced including a fully digital audio mixing system (D-Radio) and a video storage and editing system with similar functionality to D-Cart, which will be marketed as V-Cart.

Other developments in the pipeline include a reliable radio 'people meter' and a miniature outside broadcasting unit that would compress the contents of a normal OB van into two suit case size packages, including a Ku-Band satellite link. The people meter is being developed in conjunction with the University of Technology in Sydney and is believed to be a world first. It is based on an extremely compact device that can be attached to any radio and will correctly record the station the listener is tuned to.

The ABC has also had great success with the development of miniature cameras for television, particularly for a range of outside broadcasting applications. Our miniature cameras have the capability of being fully integrated into an OB production, including normal remote camera control functions, a data link and production/technical talkback. We have developed a most effective arrangement for a camera and motor bike combination which allows the cameraman nearly the full range of normal shot composition capabilities.

Digital technology now permeates the ABC's television and radio studios. For example, in Radio our major national studios at Ultimo use screen-based audio mixing technology, digital editing in all studios using D-Cart and a fully digital network switcher. ABC Radio's program distribution and transmission network is scheduled to be fully converted to compressed digital technology during 1994.

We also have plans for converting the majority of our television distribution network to compressed digital technology, with a target date of early 1995. Planning for this is now well advanced. The new system will replace our present analogue distribution system with a multiplexed digital system, with much lower operating costs.

From a strategic point of view, the use of the latest and most innovative technology over recent years, coupled with modern work practices has benefited our programming, reduced our unit operating costs and placed us in a sound position to meet the challenges of the future.

The development of our own specialised broadcasting technology, together with its manufacture and marketing is also helping to widen our financial base and enhancing our reputation as a leading edge broadcaster. Our ABC designed products are used in our studios every day and we are pleased to see the adoption of this same technology by so many of the world's leading broadcasters.

OFFSHORE OPPORTUNITIES

The ABC has made a significant investment in time, money and its people and is well positioned to provide a range of broadcasting services to other countries.

The ABC has advantages and strengths in marketing its services, especially in the Asia/Pacific region. We are a part of Asia and English speaking. Australia has a stable political climate and is generally seen as being a fair trader. Our capability to deliver broadcasting assistance and related business opportunities does not happen by chance. The ABC has been a broadcaster since 1932 and has devoted considerable resources to developing and modernising its own management, practices, processes, staff skills and technology. The development of high quality training courses has been a key element in this process.

We provide specialist consulting, training and development, technology assistance and advice, program sales and exchange, as well as staff exchange in most areas of broadcasting. These capabilities extend from running a small, one or two-person radio station up to a huge national network with hundreds of transmitters.

The ABC has developed staff and resources which are devoted to responding to needs in this area.

We also have 23 overseas offices for news gathering and distribution as part of our commitment to providing Australia with a comprehensive view of world affairs.

In the Asia/Pacific region, we have International Bureaus in Beijing, Bangkok, Hanoi, Hong Kong, Jakarta, Manilla, New Delhi, Phnom Penh, Port Moresby, Singapore and Tokyo. These countries represent about one half of the world's population.

Over the last 12 to 18 months we have provided consulting, training, aid or programs to many countries including Papua New Guinea, Thailand, Brunei, Vietnam, Laos, Cambodia, Indonesia, Malaysia, China, Singapore, India, Pakistan, Fiji, Tonga, Vanuatu, Ghana, Sierra Leone, Zambia, Mozambique, Bangladesh, and Jordan.

INTERACTIVE VIDEO

One of the more interesting and promising products to emerge over the last year or two is Interactive Video (or television). Interactive television services have already started in several countries, although mostly on a limited basis. Several technologies have been proposed with results so far being rather uncertain.

Australia is in a somewhat different situation from many other countries for interactive television because of two special factors. Australia doesn't have any significant cable, satellite or MDS television at present and there has been no attempt to mandate any particular delivery technology for interactive television.

That provides an opportunity to implement an interactive television system based upon the present free-to-air broadcasting system as the delivery technology. Because there are no significant cable or satellite DBS systems it also means that the home marketing field is a major potential application for interactive television.

Interactive television is very different from broadcast television. and its success is far from assured Television is about broadcasting while interactive television is about making contact with individuals in the audience. Its nature is much more akin to a one to one service.

The ABC considers the chances of successful implementation of interactive television are higher in Australia than in many other countries. Because of the ABC's objective of remaining at or near the leading edge in the development of new technologies and services, it expects to be a participant in this technology and its related services.

MULTIMEDIA

Multimedia is still a rather nebulous concept being primarily the outcome of a merging of several technologies and services. These cover computing, telecommunications, broadcasting, consumer electronics and the more general information and entertainment industries. These industries are now overlapping significantly into each other's previously nicely segmented business.

Multimedia is not about technology. It is about markets. Multimedia will offer an unstoppable range of services providing consumers with an enormous increase in control, choice and convenience.

In many communities and countries, it will not be long before broadband ISDN or video cable technology brings an information highway close to the door of people's homes, perhaps with a short wireless or copper loop for access. This will be accompanied by a revolution in technology that will in due course bring a waterfall of products and services.

In facing the challenge of multimedia, the ABC is no different from many other broadcasters around the world. At present we have almost total control over our sources of product, the compilation of those products into networks and services and their delivery to our customers, the audience. Multimedia will change that arrangement by providing exciting new opportunities for public broadcasters to meet their charter obligations. In our view, broadcasters will have the opportunity to thrive in this new environment. *The Show is the Thing!*

We can be certain that making a multimedia program will be mostly very different from making a program 'multimedia'. New computer applications which combine text, graphic, audio and video in a highly interactive manner will offer a strong challenge to traditional program makers.

Multimedia will certainly allow many enthusiastic amateurs with an artistic or entrepreneurial flair to succeed. There will be plenty of room for these people. But we believe there will continue to be a strong need for professional audio and video production talent to serve the multimedia environment. We have that talent.

A key factor in the delivery of audio and video services will continue to be a need to entertain, inform and educate an audience. This will need to be done in innovative ways but often with a local emphasis. For example, the ABC sees a continuing need to provide programs about Australia. Multimedia and global communications developments will allow these programs to be much more readily accessible on a global basis.

The ABC has several specific service and product areas that present opportunities in a multimedia environment. These include:

- Extensive archives of video, audio and text.
- In-house creative production resources
- Expertise in children's, documentary, information and entertainment programming.

BEST COPY AVAILABLE

- Expertise in production of creative material in audio, video, CD and print form.

- Innovative Australian production and programming strategies.

- Highly computerised information management and production processes.

- A large established retail distribution network in Australia.

Many opportunities will arise as multimedia services become available and are adopted by our audience. For a national broadcaster, the challenge is to extend its traditional role so that it can participate fully in these exciting new audio/visual technologies.

As multimedia services grow, a number of related issues will need to be addressed. Many of these relate to regulatory, legal and standardisation issues. These include:

- Regulatory; separation of content and carriage.

- Protection of intellectual property and copyright issues.

- Industry structures; collaborative relationships, strategic partnerships, alliances.

- Managing a new industry; broadcasting, telecommunications, computing, print, publishing, computing, consumer electronics.

- Technology; open standards and costs

- Export and international services; an information service industry for the 21st century.

CONCLUSIONS

Key strategies for the ABC in the environment of technology convergence are:

- Remaining committed to our charter of being distinctly Australian, providing information, education and entertainment programs, and being innovative.

- Staying connected with the audience.

- Understanding the technology and developing service opportunities.

- Retaining both a domestic and an international focus for opportunities

- Continuing to effectively manage our cost structures and staff skills to maximise delivery of product to our audience.

- Vigorously protecting our intellectual property and strongly resisting restrictive practices that would lead to monopoly access rights to homes.

- Collaboration and co-operation together with competition as a way of doing business in the future.

Cable TV Industry in Korea
and the Business Strategy of Korea Telecom

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1. ABSTRACT

This Paper introduces the development and market structure of multi-channel cable television industry in Korea, and presents business strategy of Korea Telecom evolving cable television network into B-ISDN, which provides high capacity transmission pathway delivering voice, data, and video services.

2. INTRODUCTION

Recent environmental changes such as radical technology developments, introduction of competition, market opening pressure from outside, growing consumer needs for high-level diverse services are compelling telephone companies to renew their business strategies. To cope successfully with these challenges, Korea Telecom planned to develop into a broadband telecommunications operator with diversified service categories. As a consequence, Korea Telecom resolved to initiate cable television business on purpose of constructing a broadband communications network, which is capable of providing high capacity transmission pathways offering voice, data, and video services over an integrated network.

The purpose of this paper is to introduce the development and market structure of cable television industry in Korea, and to present the business strategy of Korea Telecom to develop toward B-ISDN through cable television network.

3. DEVELOPMENT OF CABLE TV INDUSTRY

In Korea the oligopolistic structure of two public broadcasting networks, KBS(Korean Broadcasting System) and MBC(Munhwa Broadcasting Corp.), had been maintained for a long time. The Korean Government changed broadcasting policy steeply in 1991. The broadcasting system was rearranged in such a manner as to have public and commercial broadcasting coexist, and new media like multi-channel cable television and DBS (Direct Broadcasting System) got decided to introduce. The initiation of new media services in Korea is expected to 1) meet people's diversified information needs and 2) keep step with recent technology development , and 3) prevent cultural colonialism caused by spill-over of direct satellite broadcasting from Japan and Hongkong. Especially multi-channel cable television service has attracted public attention in that it has a remarkable far-reaching effect.

Cable television service that retransmitted over-the-air TV signals originated in early 1960s and has embarked for the poor reception region. Today, the number of relay-only cable systems soars to 858, which have more than 3 milllion subscribers. However, these systems operated by small-scale businessman have provided low-level service and could not embrace technology development. The Government recognized the necessity of service improvement and speculated the adoption of a new cable television service in 1987. Also to establish political directions for new media services, the Government constituted a study committee composed of communication experts and scholars. The constitution of the Cable Television Promotion Committee and the promulgation of the Korean Cable Television Act were based upon research results of the committee and opinion of the public hearings.

89. 5.	Foundation of a Study Committee on Broadcasting system
90. 4.	Foundation of Cable TV Promotion Committee
90. 9.	Establishment of Cable TV Demonstration Center
91. 7.	Commencement of Demonstration Broadcasting
91.12.	Promulgation of Korean Cable Television Act
93.	Designation of Service Providers
95	Commencement of Cable Television Services

Table 1. THE CHRONOLOGY OF MULTI-CHANNEL CABLE TELEVISION IN KOREA

On the other hand, the Government appointed Korea Telecom to a demonstration broadcasting service provider to start a pilot broadcasting service for the residents of a large apartment complex. Under the guidelines of government policy, Korea Telecom built a CATV demonstration center, and operated 5 channels for re-transmission of over-the-air broadcast signals, 3 channels for original programming, and 3 channels for FM music broadcasting. Along with the cable television service, Korea Telecom tested telemetries and the safety against crime and fire, and also conducted several response surveys of the audience. But the demonstration broadcasting of Korea Telecom didn't appeal to the audience because it was mainly involved with technical examinations without sufficient programs. In December of 1991 the Cable Television Act was promulgated, then the enforcement decree and ordinance was announced, after that the Government designated service providers last year. The year 1995 is the time that a new cable television system will start its service. The major proceedings with regard to the introduction of new cable television service are presented in Table 1.

4. INDUSTRY STRUCTURE

The cable television industry in Korea has some specific characteristics. The Government proposed unique industry structure different from those of other countries. The industry consists of three independent providers, that is, system operators, program providers and cable network providers, which are not subject to cross-ownership excluding exceptional cases. To depict the industry structure in Korea, we will briefly deal with the role and function of regulatory authorities, eligibility of service providers, and regional division of franchise areas.

4.1 Role and Function of Regulatory Authorities

The industry in Korea is under a complex regulatory environment involved with Ministry of information, Ministry of Communications, Korean Cable Communications Commission. These 3 regulatory authorities play separate and independent roles. The Ministry of Information, in charge of broadcasting policy, has the right to endow franchises to system operators and also licenses to program providers. Furthermore it can and do impose a wide variety of regulatory requirements on them.

The Korean Cable Communications Commission exercises jurisdiction over cable programing. The Commission screens programs before broadcasting, and decides whether it is appropriate for broadcasting. It can also make suggestions to settle audience complaints and recommands long-term policies for cable television industry.

Ministry of Communications takes charge of equipment installation and technical standards, and it has the right to designate network providers.

4.2 Eligibility of Service Providers

The cable television industry in Korea, as mentioned above, is divided into three parts; Program Provider, System Operator, and Cable Network Provider, which must be under separate ownership. Program providers provide system operators with cable programs produced by themselves or purchased from other program producers. There is no entry barrier into cable programming except for news programming. Media scholars expressed worries that multi-channel media in Korea will bring about increase of foreign programs, as shown in movie and video rental markets, and result in cultural dependency. The issue of cultural dependency has been a ongoing debate in Korea. Considering these worries, the Ministry of Information limited cable programing with minimum self-production ratio of 20%, maximum foreign program ratio of 30%.

System operation is the most regulated area in the industry. The Government prohibits multiple ownership of cable system, and strictly limits the qualification of individuals or corporations that can invest in the area of system operation. Daily newspaper and over-the-air broadcasting companies, conglomerates, foreign investments, political parties and religious groups that have certain ideologies are restricted to be system operator. Additionally a franchise period is just 3 years, and those who want to renew the franchise after expiration must acquire re-license from the Ministry of Information. Also system operators must provide at least one channel for public and may have a channel for regional access. These severe restrictions on system operators are intended to prevent media concentration and promote positive function as a regional media.

Cable network provider separated from system operator installs and operates cable television networks. It is different from those of the US and Japan where the system operators take charges in installation and maintenance of cable network. More than two network providers should be designated according to the Cable Television Act. The major candidates are telecommunications companies like Korea Telecom and DACOM (Data Communications Co.) and KEPCO(Korea Electric Power Co.) which is providing electric power service in Korea.

4.3 Regional Division of Franchise Areas

Ministry of Information has the rights to decide franchise areas considering administrative districts, existing telecommunications facilities, living areas, and geographical conditions, etc. It announced that the number of franchises is 116 , each has average 100,000 households, and would be granted phase by phase. To begin with, 57 franchise were selected in the urban areas last year. Following areas and schedules will be decided after reviewing thoroughly the accomplishments of service providers which got licenses last year.

5. THE PROSPECT OF CABLE TV MARKET

The subscription rate of multi-channel cable television is estimated to be 20% of whole households and its market volume will amount to $600 million in 2000. However, there are pessimistic prospects as well as optimistic ones. It is hard to predict the future of cable television industry because the basic features such as service contents and formations multi-channel cable television systems provide are not fixed yet. Furthermore, multi-channel cable television must vie with powerful competitive media. The penetration rates of TV sets and VCR in 1992 are around 99% and 57% of gross households respectively, and existing relay-only cable television services are also available to a lot of households. A Korea-specific state of things limits to analogize the future prospect of cable television in Korea from the cases of advanced countries as well.

Many countries in the world have introduced cable television service ahead of Korea, but only a few of them, like US and some European countries, are classified to have made a success. To reach the current successful condition, these countries have endured long-periods of trials and errors. As there are innumerable factors that actually affect the success of multi-channel cable television in Korea, nobody can jump to a conclusion at present whether the cable television service will succeed or not. Some factors among them act as positive ones. For example, we can find a lot of poor reception areas of over-the-air broadcasting and media consumers have been surfeited with the programs over-the-air networks provide. Also multi-channel cable television service will be introduced before DBS and the needs for cable television service in the more-educated groups of urban areas are considered strong enough to back up the industry. In spite of these positive factors, we can find many negative factors as well, which work in the direction against the diffusion of cable television. Software and hardware industries related to cable television are not developed well enough to support the industry, and increasing number of nation-wide and regional over-the-air networks are planning to start their services sooner or later with the Government's permission. VCR and video rental service are now popularized and prospering. Considering the household income of Korea, subscription fee and monthly charge of the new cable television service will be a burden to the majority of media consumers. Though cable television business is affected by these positive and negative factors, two variables, programs and rates of cable television service, are eventually the most decisive one. Several consumer surveys show that potential subscribers are very sensitive to rates and programs. To succeed in the competition with other media services, multi-channel cable television must provide better programs at a reasonable price than those of other media services.

6. KOREA TELECOM'S STRATEGY FOR THE CABLE TV BUSINESS

6.1 Strategic Background

The fundamental long-term strategy of Korea Telecom is to evolve cable television network into B-ISDN, which delivers high capacity transmission pathways offering voice, data, and video services over an integrated network. There is a trend that consumer needs are changing from voice communications to video communications. Korea Telecom expects to meet these growing consumer needs by offering diverse services over cable television network such as video distribution service, video phone, video conference, home shopping, etc. The cable television business is the first step of Korea Telecom on video information industry. Korea Telecom had decided to enter the cable television business because it is the only feasible service at present among broadband telecommunications services and one of the related diversification fields where Korea Telecom can apply its established know-how and facilities. The strategic background of cable television is as follows;

First, Korea Telecom needs to make a balanced portfolio of its service categories by entering the cable television business. Up to now Korea Telecom has flourished as a dominant telecommunications company in Korea. As the basic telecommunications market, however, is approaching its saturation point, the profit basis of Korea Telecom is agitated. The introduction of competition also endangers Korea Telecom's growth. In Korea a new carrier already entered the international telecommunications market, and the Government is considering the introduction of competition in the long-distance telecommunications market. There is also a strong pressure in consumer side. The consumer needs for broadband information services are increasing and they will. That is the basic reason why Korea Telecom endeavors to enter the cable television business and strengthen its information services. The cable television industry has a great potentiality of growth and its network is expected to work as an infrastructure of the coming information age. Looking inside the business feasibility, however, the prospect of the industry is not always good. Especially the cable network provision that is the main scope of Korea Telecom's cable television business is very risky because the business needs tremendous resources and advanced technology. Korea Telecom had decided to enter the cable television business from a long-term perspective, not a short-term one.

Secondly, the cable television business comes under the related diversification field to which Korea Telecom can apply its established facilities and management know-how. Korea Telecom enables to exploit the economies of scale and scope by binding cable television business with telecommunications business. It also helps to secure the competitive advantages in multimedia age that is characterized as the convergence among diverse industries. In the middle of the 90's Korea Telecom will secure a couple of multimedia infrastructure consisted of wired and wireless broadband network via cable television and satellite businesses.

Another background that Korea Telecom decided to enter the business is found in defending its telecommunications business from cable operators. Recent technology development, especially digital compression and fiber optic cable, makes cable systems offer telecommunications services. If the cable television network evolves to serve two-way communications, it can provide basic and enhanced telecommunications services by adding the switching function to its system. Korea Telecom may constrain cable systems' entrance into telecommunications market by going into the network provision of cable television industry. The most efficient way toward B-ISDN is that a telecommunications company like Korea Telecom constructs the cable television network and pursues the network integration between telecommunications and cable television. It is desirable for both national economy and Korea Telecom.

6.2 Korea Telecom's Business Plan

Korea Telecom has a plan to enhance its cable television network gradually by substituting fiber optic cable for coaxial cable, which will undergo 3 stages to accomplish a complete fiber subscriber line as a basis of B-ISDN. This 3-stage plan was set up because coaxial cable will be cheaper than fiber optic cable for the time being and fiber technology is not fully developed yet. In the first stage Korea Telecom will employ coaxial cable for the cable television network. In this stage only the backbone structure connecting headend and distribution centers will be constructed with fiber optic cable. From the second stage, which will be around 1996, fiber optic cable will be introduced in subscriber lines step by step. In the third stage(from 2002) Korea Telecom will apply Fiber-To-The-Home network architecture. What parts of subscriber lines Korea Telecom will employ fiber optic cable in depends on the development of fiber technology and the construction cost of fiber network architecture. Hence this time schedule is likely to be delayed a little due to these two factors, but Korea Telecom's basic strategy toward B-ISDN will not change. As the signals of cable television in tree-and-branch architecture generally run into subscribers' home through trunk cable, feeder cable, and subscriber drop cable, the employment of fiber optic cable will follow in this sequence. Korea Telecom plans to employ fiber optic cable in the backbone structure at first, and after that, fiber optic cable will be introduced in trunk cable that carries the signals from headend to feeder cables and in the feeder cable that branches off from the trunk into local neighborhoods. At last the fiber subscriber drop may be implemented, which means the completion of fiber subscriber line. These differences of fiber optic employment will make the services different that the cable television network provides. Before 2001 Korea Telecom may not serve its subscribers with the combined services of video, data, and voice because the independent switches deal with voice and video signals separately. After Korea Telecom successfully completes the construction of fiber subscriber lines, the combined services may be available to its subscribers. Korea Telecom plans to invest about $200 million every year on cable television network.

The cable television industry needs sound network for program distribution in order to provide diverse programs to its subscribers. To support the industry, Korea Telecom plans to construct the efficient network for program distribution via satellites. Satellite delivery leads the way to the cable television industry's development as a major force in providing high-quality video entertainment and information to its customers. It offers cost-effective multi-channel capacity to the system operators, and nation-wide network can be easily made up in a short time only if the system operators furnish receive-only earth station. All of system operators can receive a wide variety of specialized programming in the same condition. Korea Telecom will launch 2 KOREASAT satellites for both telecommunications and broadcasting in 1995. These satellites are expected to build up cost-efficient program distribution network, which will make a great contribution in the diffusion of cable television service in Korea.

6.3 Development Strategy toward B-ISDN

Korea Telecom plans to enlarge its service categories by providing video and high-speed data services over an broadband cable television network. Therefore, Korea Telecom pursues cable television business not only to offer video distribution services, but also construct B-ISDN infrastructure. To provide broadband services successfully such as video information services and high volume data transmission services, a new communications network which can handle more than 100Mbps should be installed in the subscriber lines. Accordingly, fiber optic cable(at least coaxial cable) should be employed as a transmission medium. The main advantage of fiber optic cable is that a signal can be carried greater distances without loss of power and subsequent need for amplification, thereby providing more channels and high quality. Korea Telecom, as said, plans to start fiber employment on subscriber lines of cable television network in 1996, and improve network efficiency by offering additional video information services through spare channels and providing high-quality combined broadband services of video, data, and voice. Since the late '80s Korea Telecom has made efforts for practical use of fiber optic cable connected with B-ISDN.

While B-ISDN is very efficient in offering telecommunications and cable television services over an integrated network, it is widely accepted that it costs too much time and money. Therefore, Korea Telecom plans to take 3 step approach toward B-ISDN, that is, individual provision, physical integration, and service integration.

a) Individual Provision : The first step is constructing an independent cable television network separated from existing telecommunications network. In this step two networks have independent transmission and access standards. Therefore it is impossible to provide the combined services between telecommunications and cable television, and there is also difficulty in providing video information services. The cable television network, however, can be constructed within a short period of time without consideration for transmission and access standards of telecommunications.

b) Physical Integration : This step stands higher from a technological standpoint than the individual provision, which integrates the subscriber lines between telecommunications and cable television network. In this step two heterogeneous services hold physically a common subscriber line but are offered through separated pre-arranged pathways. That is to say, while the physically integrated network provides both telecommunications and cable television services through one subscriber line, cable television services are offered by broadband switch(or one-way distribution switch) separated from the telecommunications switch. From a logical perspective, therefore, there are two independent communications networks.

The physically integrated network will be cost-effective in due period because cable television may be the unique broadband service for a long time that makes profits and it will take much time to enable to offer the combined information services after the implementation of fiber subscriber lines. This step gives a chance for network provider to operate fiber subscriber line efficiently and also has an advantage in that it is easy to evolve into the service integration only by employing ATM switches. The physically integrated network, however, has many troubles in providing combined services of video, data, and voice.

c) Service Integration : In the service integrated network all the functions of network such as switching and transmission, are integrated, and therefore all the communications services will be offered through one integrated network consequently. As the standard transmission speed of B-ISDN is 155Mbps, service integrated network even enables to provide HDTV service and combined information services beyond traditional video distribution service. If cable television network evolves into the service integration, diverse communications services can be developed and commercialized easily. Hence it is expected that the service integrated network makes great contribution to the development of multimedia services.

However, there are some problems in this step, which are due to different transmission speeds or bandwidths along its diverse services. First, it is very difficult to make a consistent tariff structure. In the service integration all the services are offered over one integrated network, from video services that need several or several tens Mbps of transmission speed to voice and low-speed data services that merely need several Kbps. In the physically integrated network these services are offered through separated channels and different tariff structures can be applied to them without any confusion. But if the tariff is imposed on each service in accordance with bandwidth in the service integration, which seems reasonable, the tariff of video services has to be imposed several hundred or thousand times higher than that of voice and low-speed data services. In this case the tariff structure may suppress consumers' demand for broadband information services. Secondly, if a discount system is introduced to boom up the video communications services, it yields inefficient subsidy from voice services to video services and the channel reselling that someone leases broadband channels and sells it to someone else with narrowband, low-speed services. The legal and regulatory system to settle these problems should be developed in advance before this step.

6.4 Korea Telecom's R&D Activities

subscribers. In addition, Korea Telecom has gone on several R&D activities to study on the development of fiber optic technology and to test its practical use. Korea Electronics and Telecommunications Research Institute has progressed a project to develop a digitized optical cable television system under Korea Telecom's support, which will be completed this year, and after that, 2 years of field experimentation is planned. Korea Telecom's R&D departments are engaged in 2 projects related to fiber optic transmission. The mission of PON project is to study on Fiber-To-The-Curb(FTTC) that transmits analog and digital signals via fiber optic cable from the center to the curb, and FLC project has investigated the feasibility of Fiber-To-The-Office and the enlargement of fiber optic employment. Korea Telecom expects that these R&D activities will relieve the technological dependency on advanced countries in the fields of cable television and fiber transmissions.

7. CONCLUSION

Rapid technological developments are accelerating the convergence between broadcasting and telecommunications. This whirlpool of environmental changes will be a serious threat to telecommunications companies on the one hand, but it will also provide an opportunity to progress as a diversified telecommunications company on the other hand. Korea Telecom tries to respond successfully to these environmental changes by focusing its strategy toward B-ISDN via the cable television business. But the cable television business is evaluated as very risky in that this business requires tremendous resources and relevant industries related to cable television, software and hardware, is in the infant stage. Korea Telecom eagers to enter the cable television business in spite of the risk if the business is important to realize information society and satisfy growing consumer needs. The participation of Korea Telecom in cable television business will make a great contribution to the diffusion of cable television and information services in Korea.

The Regulation of New Media in Taiwan

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ABSTRACT

The purpose this paper is to discuss the development of the new media in Taiwan and the related regulatory issues debated by government officials, academicians, the telecommunications industry. The cable laws, satellite policy, and telecommunications law emerging in Taiwan will be discussed.

Introduction

Telecommunications is now recognized as a basic technology underlying the whole global information economy and society, with important implications for political, economic, social, and cultural development (Akwule, 1992). And according to the "Missing Link," report of the independent commission for world-wide telecommunications development, telecommunications should be regarded as a complement to other investments and an essential component in the development process which can raise productivity and efficiency in other sectors and enhance the quality of life in the developing world.

Taiwan's economic achievements have been widely cited as one of the "economic miracles" of development from a poor, agricultural economy to one of the most remarkable New Industrial Economies (NIEs) in Asia. And this economic success is closed related to the telecommunications developments after the Government retreated from Mainland China in 1949.

The Directorate General of Telecommunications (DGT) in Taiwan implemented a series of the Four-year mid-term Telecommunication Devloopment Plans since 1953 to expedite the Telecommunication Modernization Plan and thus achieve the goals of providing modern telecommunications services in urban areas, popularizing the telecommuications services in rural areas, and uprading the network infrastructure islandwide, and thus forming a foundation for the future developoment (Lee, 1993). In 1981, the goal of "a telephone in every village" and automatic subscriber direct dialing sytems had been achieved, up to June, 1992, there were over 7 million subscribers for telephone service in Taiwan, ranking 16th in the world, next to Japan, Hong Kong and Singapore in Asia (Lee, 1993; Tseng, 1991). And DGT is currently accoloverting the plan of digitization so as to meet the market needs and provide a firm foundation for opening more data communication services in order to realize the goal of completing ISDN in 2000 (Lee, 1993).

After the ROC government withdrew from Mainland China in 1949, the communications policy was stringently enforced to ensure telecommunications, radio and television industries complied with the administrative policy of anti-communism and national development. Additionally, the ownership of these telecommunication outlets and facilities has been tightly controlled and monitored.

Four decads later, the status quo of the telecommunications industry changed partially because of the emergence of new communication media such as CATV and DBS, and partially because of the change in the political and economic environment. The emergence of new communication media has created a need among the general public for more choices in broadcasting programs and tele-communications services, albeit the need for more communication channels and voices has existed for quite a while.

To deal with this changing environment, the Taiwan government has started working on the revision of laws, and drafting new laws regarding telecommunications. The Broadcasting and Television Law has been revised to adopt a more open attitude toward the development, technically and politically, happening in Taiwan. And new Cable Act and Videotape Act was created in 1990-1991. The Satellite Act is under consideration by the government, too.

Although this kind of openness has no bearing on whether the future cable as well as other new technologies will be successful or not in Taiwan, it certainly provides an opportunity for all other, new and old, technologies or media to become creative and flexible in terms of self-regulation and independence without fear of government intervention. The purpose of this paper is to discuss the developments of the new media in Taiwan and the related regulatory issues debated by government officials, academicians, the telecommunications industry, etc.

An international communication scholar, Hamid Mowlana (1992), used the concept of communication ecology to discuss the changing international order for the 1990s and 21st century. And he stated that homogenization, domination, and diversification are at work in the international system requiring models and policies responsive to a renewed sense of "cultural ecology." Concurrently with the various telecommunciations developments, new issues of national and global policy consideration have emerged. This paper will focus on the discussion of cable law, satellite policy, and telecommuincations law emerging in Taiwan from an ecological perspective.

Satellite Broadcasting in Taiwan

The growth in popularity of (high and low power) satellites for the delivery of television signals and their increasing technological sophistication and power have generated a number of policy considerations. Many governments, European nations especially, have studied and tried to develoop satellite broadcasting policy to deal with the related issues. Major concerns are: should satellite broadcasting be used as a cultural and educational tool rather than as simply another source of television entertainment? How should a nation deal with unwanted satellite signals spilling over into its territory? (Negrine, 1988, pp.11-12).

The Chinese government in Taiwan worried about the spillover of Japanese TV programs when Japanese Public

Broadcsting Services (NHK) began regular 2-channel experimental television programs in 1986 using its Broadcast Satellite (BS-2b, also known as Yuri-2b). After careful consideration and consulting with scholars and experts in all areas, the Government Information Office (GIO) decided to legalize the installation of TVROs at the end of 1988 and let the trend take its course. More and more Chinese audiences in Taiwan watched satellite television programs after STAR TV launched all of the five channels since 1991. And more advertisers based on Taiwan are using STAR TV as an advertising means to promote their products and services.

Emerging Satellite Policy Issues

The emerging dramatic growth of satellite systems in broadcasting use around the world has given rise to some highly sensitive issues, including control of information, preservation of cultural identities, and even the survival of traditional broadcasting (Khushu, 1993). Many developing countries in Asia have been so worried about the impact of satellite television on their culture and audiences' viewing behaviors that all TVROs were banned.

Lau(1992) discussed the policy issues related to CATV and DBS in the Asia-Pacific region and tried to examine a triangular relationship between the government, service providers and people. Lau questioned who gas the right to own th services and who has access to the services. The same issues challenge the Taiwan government in dealing with the booming of TVRO and satellite broadcasting.

The communication policies regarding access to satllite television in several Asian nations, according to Chan(1992), can be categorized into four types: a) virtual suppression as exemplifies by Singapore and Malaysia, where access to satellite television is banned; b) regulated openness as is found in Hong Kong and the Philippines, where access is allowed, but redistribution of satellite programs is regulated ; c)illegal openness as seen in Taiwan and India, where regulations discourage the redistribution of satellite programs, and d) suppressive openness as found in China, where no access to "foreign television signals" is allowed unless permission is granted, but the law does not ban the sales of dishes.

Peng and Huieng (1991) have discussed the liberalization of the commuications industry in Taiwan and indicated that the Taiwan government never intended to apply or develop the technology of DBS for television programming delivery; the trend of receiving NHK's programs has forced it to face the problem and to reconsider the policies of controlling communication apparatus.

When STAR TV broadcasted its five channel programmes starting in 1991, the viewers in Taiwan were exposed to more programme choices via TVRO, SMATV and the so-called fourth channel. The government in Taiwan was especially concerned about the viewership of CCTV's television programmes by Taiwan audiences. Several meetings were called to discuss how to ban or deal with the so-called invasion of Communist programmes on Taiwan. It was, however, discovered that the viewership of CCTV in Taiwan was very limited and the impact seemed to be very minimal.

Ogan(1992) studied the communication policy options in an era of rapid technological change and argued that "often policymakers are reacting to pressure rather than initiating discussion on their own and exploring multiple facets of the situation. Ogan suggested that policymakers take three approaches regarding the new communication technology: (1) policy developed in reaction to technology, (2) policy formulated to anticipate technological change, and (3) policy evolved along with the development of technology. Liu(1992) had argued that Taiwan did not have a comprehensive far-sighted communication policy, so the government's policy has usually developed in reaction to the marketplace and the technology.

Taiwan once had three forms of illegal media. The first was the DPP members'unauthorized transmission of broadcast frequences. The second form was illegal Cable TV (the so-called Fourth Channel). The Third was illegal reception of foreign satellite programs (Liu, 1992). But at the beginning of the ninties, the Taiwan government revised Broadcasting and Television Law, drafted Cable Television Law, and started to assess DBS's feasibility all of which, of course, were pushed partially by the marketplace and partially by political and economical forces.

At the recommendation of Ministry of Communication, the Taiwan government plans to develop its satellite in three phases: the Ministry of Communication will rent commercial satellite transponders for use in the domestic communication system first, followed by the Government joining the investment plan of the Pacific regional satellite, and then Taiwan shall launch its own satellite.

In the middle of July, 1990, the Executive Yuan held a meeting to discuss how to open satellite channels for TV use and concluded that the government should open satellite television to everyone and should start to initiate a policy to regulate the new form of communication (Liu, 1992). When the satellite policy is under serious consideration, the Government Information Office is especially concerned about the following issues:

a). authority

Who should be granted authorities for regulating DBS? While the regulatory system of both broadcasting and communications in the U.S. and France is unified, some countries face conflicts between different authorities regarding the regulation of media content, such as Germany and Canada. Telecommunications authorities competing with broadcasting for control over valuable new outlets is quite common in Europe (Negrine, 1988). And the disputes over regulatory territory of satellite broadcasting is emerging in Taiwan.

b). content regulation

The Broadcasting Law in Taiwan set restrictive methods to regulate certain types of programmes, programme contents and advertising. And when more audiences in Taiwan prefer watching satellite programmes, it's almost impossible for the governmental agencies to control.

c). Mainland China Factor

One reason why the Taiwan Government is so concerned about the impact of satellite television is related to the political situation existing between Communist China and the government in Taiwan. For example, The Taiwan government was worried whether Asiasat I, because of its one-third ownership by a Chinese company, would subject Taiwan to a Communist propaganda bombardment.

d). access

Since AsiaSat I is the first commercial satellite in the region and its success was widely watched and discussed, many people were encouraged and wanted to jump onto the band-wagon. But who gas the right to access to satellite transponder? At the moment, the Directorate General of Telecommunication at the Ministry of Communication in Taiwan is in charge of the satellite communication, including uplink and downlink signal transmission. Private companies try to lease satellite transponders through many different different sources for broadcasting, which might violate Telecommunications Law. The issue, then, is: What kind of control can the government impose on access to satellite transponder space?(Lau, 1992)

e). regional cooperation

Due to political reasons, Taiwan has bean isolated from major international organizations. The government in Taiwan recently has bean eager to rejoin any international organization which wonld recognize the legitimacy of the Chinese Government in Taiwan. And the government is looking for any opportunity to cooperate with other countries to build a regional communication network and exchange programmes.

f). Copyright and the related law issues.

When copyright issues were discussed, Taiwan was always notoriously blamed for the lack of respect for copyrights. The government now is working very hard to try to clean her image in this domain. After the passage of the Cable Law, it is believed that the government in Taiwan should have more determined attitudes and methods to deal with issues like piracy.

Cable Development in Taiwan

One of the most important events in the Taiwan media environment of 1993 is the passage of the cable television law by Legislation Yuan. Having been discussed and fought for about ten years, Taiwan finally entered the legalized cable era.

The phenomenon of community antenna television (community TV) was a part of television development in Taiwan twenty years ago, yet it has never been treated as a new television delivery system or a new medium. It has grown unnoticed and expanded as an extension of the exisiting television systems; namely the three commercial television stations(GIO, 1990, pp. 24-25). In accordance with the present community television rules, these systems can only relay the existing television signals to those communities without television programming services.

Gradually community television has created new demands for more television programming and transformed the concept of community television into a total different medium phenomenon. And no law thus allowing extra signals transmitted through community television, systems playing existing video movie tapes, broadcasting satellite signals, telecasting other video sources not only would be a violation of the Broadcasting and Television Law, but also would infringe on the intellectual property rights. These kindes of illegal systems have applied the same technological thinking of CATV and have been named as the "fourth-channel."

The Government in Taiwan first decided to explore the possiibility of establishing a CATV system in Taiwan in 1983 and was under the directives of the Administrative Yuan. The Yuan indicated that CATV could be valuable to Taiwan industries and communication needs. The potential benefits would be:(1) reducing areas presently underserved or unserved by over-the-air television services; (2)providing more radio and television channels for broadcasting purposes; (3) matching the development of ISDN; and (4) eliminating the illegal "fourth-channel" problem.

Under the Administrative Yuan's directive, the Government Information Office and the Ministry of Communication assembled a group of scholars in mass communication, economics and law to form a task force to draft a cable Policy Act in 1990.

It seems that there is a compelling interest for the public to have a new television delivery system and that the regular cable system could become a reality at the end of 1994. It is also crucial to state that, for the first time, the cable act encourages all parties' participation without reserving channels for party or governmental interests, and shows a new "open" policy in the new telecommunications media which permeates all sections of the proposed CATV rules.

The Cable Law of Taiwan

The 1984 U.S. Cable Act provides several guidelines and parameters in granting licences for applicants, such as distant-signal rules, sports black-outs, original programming and technical standards, equal employment opportunity and consumer privacy, cross-ownership, must-carry rule, and theft of services. The FCC has also considered regulating cable's copoyright, franchising, utility-pole attachments, rate and pre-emptions,etc.(Blumenthal & Goodenough, 1991).

Hong Kong's cable experience, on the other hand, represents cable development in a newly industrialized Pacific Rim. The key issues raised in H.K. hinged on whether: (1) the cable franchise should be exclusive or competitive, (2) ownership would be public, private or foreign; (3) other media and telecommunications companies could have an ownership interest in the cable company; (4) programmes should be advertiser-supported or commercial-free; and (5) current sources of programming were adequate or significant importation would be necessary (Lau and Baldwin, 1990).

Most of the countries wired by cable adopoted the policy of 'one area, one system'; the exclusive cable franchise is based on the assumption that there was a 'natural monopoly' and on potential franchise applicants' belief that the cable distribution system needed exclusivity and programming control to assume the risk. The cross-media ownership was restricted in most countries.

The major characteristics of Taiwan's Cable Law will be discussed as follows:

a). An "FCC-like" agency

The authorities-in-charge as mentioned in Cable Law shall be the Government Information Office of the Executive Yuan in the central government (the "GIO); the Provincial (Municipal) Department of Information in provinces (municipalities); and the County (City) Department of Information in counties (cities).(Article 3) There is no FCC agency in Taiwan which is the principal government agency that regulates the television business in the United States.

Granted by the Cable Communications Policy Act of 1984, the FCC regulates the operation of cable systems in the U. S.. In many instances, this power totally pre-empts the authority of state and local governments (Blumenthal, 1991, p.120).

One unique characteristic of Taiwan's Cable Law is to build a Review Commission for Cable Television which could be a kind of FCC agency to grant licences for cable applicants. According to Article 8, the central authority-in-charge shall establish a Cable Television Review Commission (Review Commission) to review the following items: 1). operation permits or revocation of permits for cable television, 2). issuance or renewal of licenses for the system operator, 3). evaluation of execution of operational plans, and 4). other items regulated by this Law or sent for review by the central authority-in-charge.

The selection of government officials to the Review Commission that awards the cable franchises had been debated hotly during the legislative process. Many people were worried about the overrepresentation of governmental officials in the committee which might cause it to lose its neutural and independent image. And now the Review Commission shall have 13 to 15 Commissioners and be composed by the following persons: 1). eleven to thirteen scholars or specialists; 2). representatives of the authorities-in-charge; each one be sent by the GIO and the MTC. And the number of the Review Commissioners who belong to the same political party may not exceed one half of the Commission. During the tenure of office, the Commissioner is not allowed to attend any political party's activities(Arrticle 9).

The success of Cable Law is dependent on the wisdom and courage of the commissioners of the Review Committee who work part time for the commission and have a full time job elsewhere. Some scholars were quite pessimistive toward the establishment of FCC-like agency because it's very difficult to be totally independent from the influence of government, political parties, and business. And the work load is too heavy for any partimers to handle in time.

b). no cross-media ownership

According to Article 20, existing newspapers, broadcast television or radio industries and directors, supervisors and managers of these media enterprises shall not be allowed to be applicants, directors, supervisors or managers for any cable television system.

At beginning, all three television stations wanted to become cable ooperators and program providers. Technically, these terrestrial broacasters were confident in handling the hardware technology. And they believed that they were the most competent candidates in managing television business. If they were granted the licences to start cable business, three television stations could diversify their investment and increase profits. The government, under heavy pressure from the terrestrial broadcasters, finally refused to let the broadcasting services and other media outlets became cable operators due to the unfair competition.

c). no foreign investment

Many foreign cable companies are very interested in entering Taiwan's market due to her economic performance and intensified geographic condition. But Article 20 states that the operators of cable television shall possess R.O.C. citizenship and the structure of cable television operators shall be limited to a corporation limited by shares of foundation. No foreigners shall be allowed to be sharesholders of a cable television system.

d). one area, five cable system

One of the hottest debated issues in Taiwan is related to how many systems would be allowed within one area. Almost every legislator has been against the idea of one company (system operator) and one territory (exclusive franchise area) when they discussed the exclusive franchise area. And the most compelling argument was the fear of a monopoly of political resources by the local cable company (Chang, 1992). Chang, a consultant in cable business, asserts that "Taiwan might well be on her way to becoming the first country to commission an 'overbuilt' cable system." (Chang, 1992, p.44)

And Chang's right, according to Article 27, that no more than five cable television systems shall be allowed to operate in any given area. And division and adjustment of said area shall be conducted and publicized by the central authority-in-charge after judging the following circumstances and consulting with the MTC: 1. administrative zoning, 2. natural geographic environments, 3. distribution of population, 4. economic benefits.

Telecommunications Regulation

Taiwan policymakers have recognized that communications reform is required if she would like to enter the so-called industrialized family of nations. Taiwan is also interested in replacing Hong Kong to become a financial center, a transportation center and a science & technology post in the west Pacific region after 1997. At the geographical center of the west Pacific rim, Taiwan has excellent conditions for becoming a telecommunication network center in Asia (Tseng, 1991).

Stating from 1968, the Directorate General for Telecommunications (DGT) was thinking abont the issues of privitization. The pace was very slow. In 1987, a study of modern telecommunications laws and regulations was initiated by the Council of Economic Planning and Development (CEPD). Later, DGT launched regular meetings for further deliberation and future planning. After that, the Ministry of Communications (MOC) established three ad-hoc groups to work on telecommunications liberalization, corporatization and legalization (Tseng, 1991). And various structural options have been evaluated by the experts and government officials. Currently, a draft law that would reform the telecommunications sector is being circulated.

But the slow movement in Taiwan telecommunications reform has upset a lot of concerned parties, including large users and Taiwan's trading partners. Observers speculated the slow progress might be a result of several factors. Taiwan has been subject to less significant external and internal pressures to open the telecommunications sector. The Cable Law, for example, was pushed by the U.S. Trade Representative and U.S. industries. In addition, widely felt concerns over national security issues have delayed consideration of steps that would permit competition and encourage reform in a sector as vital to national interest as that of telecommunications.

According to the drafted Telecommunications Law, the DGT remains a part of the Taiwan Ministry of Transportation and Communications. And the operational and regulatory responsibilities remain bundled in the Ministry. The draft law contemplates dividing the telecommunications sector into two categories of service, a hybrid of the approaches that have been pursued in Japan (Type I and Type II) and the United States ("basic" and "enhanced services"). Category II services -- intended to be value-added services that use the facilities of a Category I enterprise -- could be provided on a relatively competitive basis. Presumably, Category I services -- defined as the installation of telecommunications facilities that provide telecommunications services -- would (aside from mobile services) remain a monopoly of the corporate successor to the DGT.

The draft contemplates that the DGT would be transformed into a state-run company, Chinese Telecommunications Company (CTC), which would be permitted to provide both

Category I and II services, subject to the requirements that there be no cross-subsidies.

Professor Fan-tung Tseng, a former commissioner of The Research & Planning Committee at DGT, proposed a conceptual diagram for a modern legal framework as shown in Figure I. He stated that Taiwan has a CPE free market environment in which users can purchase their own terminal equipment. And many VAN providers lease basic circuits to offer value-added telecommunications services, and become so called Type II telecommunications. Prof. Tseng believes that Type I operators have serious social obligations and should pay close attention to new technologies and provide cost-effective and price performance services, and Type II operators should provide multiple information network services.

Many scholars, however, argue that political process generally protects established interests against social change. Pool (1990) has stated that in almost evey country, one of the key issues on which the conflict between new communications technology and domestic policy is being fought is that of the PTT monopoly. The drafted Telecommunications Law obviously protects the monopoly position of DGT which might not be easily accepted by the public. And many people in Taiwan predicted that the government would have hard time persuading the legislators and the general public to accept the concept of monopoly anymore. And probably that's why the draft has not been passed by Legislation Yuan this year. Unless a more open and advanced Telecommuications Law is presented to the public, many experts in Taiwan believe that the current draft will never become a law.

Conclusion

The growth of cable television, satellite communication, and high speed computing by the 1970s began to disrupt the existing structure(Neuman, 1992). Every nation around the world, whether thay like it or not, has been forced to face this changing domestic and international communication order. Policy research received more attention in the 1980s bringing togethor scholars from political science, public administration, economics, broadcasting and telecommunications, etc. Deregulation, spectrum regulation, rate regulation, content regulation, equity issues, privacy and security issues, education and training, industrial rivalries, and free markets versus core infrastructure (Neuman, 1992) are the key issues and concerns in the field of telecommunications which need a lot of effort to study, and the results might be helpful to the policy makers.

This paper discussed the current status of cable law, satellite policy, and drafted telecommunication law in Taiwan. And the major characteristics and considerations related to the law making process have been elaborated. The main themes of Japanese new media policy are informatization and regional development. and the policy goals of new media in Korea are to promote national prosperity (i.e., public goods). Pael-Je Cho(1992), the president of the Korea Information Society Development Institute, suggested that Korea make clear-cut and specific new media policy objectives, and stndy an approporiate approach to achieve them. For the Chinese government in Taiwan, the priorities of new media policy objectives have not been determined yet. More research and dialogue between government officials, academicians, and the related industry are needed.

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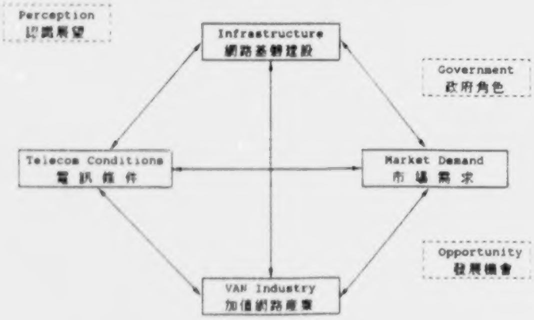

Figure 1. The Competitive Advantage of A Telecom Network Center

HIGH BANDWIDTH INTERNATIONAL VIDEO VIA FIBER OPTIC CABLE

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1. ABSTRACT

The proliferation of trans-oceanic fiber optic cable systems coupled with declining bandwidth costs is making fiber a practical medium for the international transmission of live one-way and interactive two-way video. Applications will evolve from entertainment, news, sports and special event programming to the support of education, medicine, R&D, business management and manufacturing. When coupled to domestic terrestrial and satellite distribution networks, trans-oceanic fiber systems are a powerful ingredient to encourage enhanced services to both developed and undeveloped countries.

1. INTRODUCTION

One only has to look at the headlines over the past few years to understand that we're in the midst of a revolution on how we think about *delivering* communications. Traditional perceptions are becoming outmoded and are being kicked aside by regulatory and competitive action as well as by technological advancements. While not welcomed by every player, these changes have far-reaching benefits to both developed and undeveloped countries.

Taken in the broadest sense, what we're seeing is an adoption of the Negroponte Switch: what we now receive through wires -- chiefly voice -- will move to the air, and what we receive through the air -- chiefly video -- will move to wires.

The result of this switch, according to MIT Media Lab's founder and director Nicholas Negroponte, is substantial. The broadcast spectrum will be used to communicate with things that are mobile, while fiber will be used to deliver information and entertainment to the desktop or living room.

What supports this argument? There are several examples. Let's take them in the order suggested by Negroponte.

One example of how communications are moving from the wires to the air is AT&T's purchase of McCaw Cellular Communications in a $12.6 billion deal that will be one of the largest-ever telecoms acquisition. AT&T's goal is a comprehensive nationwide wireless telephone network.

As another example, companies like RAM Mobile Data have deployed shared, two-way wireless packet data networks supporting E-mail and a wide range of vertical markets in the U.S., the U.K and Canada.

Travel-intensive executives, service, sales and other personnel can communicate with each other and central databases through their personal digital assistants (PDAs) without plugging into a phone line.

But examples are not confined to the United States. In Europe, a unified digital mobile communications network is being deployed to support telephony and data services. Eastern European countries are benefitting because they don't have to wait for an upgraded terrestrial delivery infrastructure. Mobile systems supported by international roaming agreements are being deployed in China and other regions of the Pacific Rim for the same reasons.

Indeed, the rapid adoption of mobile telephony systems suggests that the concept of wireline-based telephone networks to provide universal subscriber service may be outmoded. Wireless technology may be part of the answer to providing the "missing link" in speeding the provision of improved communications to underserved regions of the world over the next ten years.

But wires will continue to support cellular and packet networks by interconnecting base stations and switching centers. At the same time, the concept of fiber-distributed programming (both informational and entertainment) is moving ahead, fulfilling the second part of Negroponte's prediction.

All of us are familiar with fiber-based public and private videoconferencing networks. But it's useful to look at developments in the entertainment industry which, as we'll see later, will provide the incentive to deploy the networks that will also carry educational and informational services.

For example, last August, a U.S. district judge in Virginia ruled that the 1984 Cable Act's cross-ownership provision is unconstitutional. This could pave the way for U.S. telcos to offer video programming directly to customers *within* their service areas. (They are permitted to offer video programming *outside* their service areas.) Ultimately, several hundred channels of programming, including interactive multimedia television, could be available to end users via telco-provided terrestrial networks.

On a more local level, fiber optics were used to transmit the composite images of dinosaurs used in the filming of

"Jurassic Park" between Industrial Light & Magic in San Francisco to Amblin Entertainment in Los Angeles, where the animation scenes for the film could be reviewed by the film's director Steven Spielberg. This was a motion-picture industry first for film editing, and replaced overnight delivery of videotapes.

2. A DEVELOPING INFRASTRUCTURE

Regardless of the outcome of the Virginia district court action, telecom and entertainment companies along with other investors are at work building the infrastructure to provide enhanced video services to business and residential users. One of several examples is US West, one of the seven regional Bell operating companies in the United States. US West is investing $2.5 billion in Time-Warner Entertainment's Full Service Networks project to build a communications, entertainment and information services network. Toshiba and Itochu are also investors in the project. The deal will help Time Warner deploy a fiber-based network in Florida that will provide 4,000 services ranging from interactive learning and games to home shopping, home banking and other personal communications services. The television set as we know it today will be replaced by the telecomputer.

US West, in turn, plans to deploy fiber and coaxial cable across 14 states outside its service area to deliver video dialtone and video on demand to 13 million households.

Another example in the U.S. is Vyvx, the TV service unit of WilTel, which operates one of only four nationwide fiber optic networks in the United States. Vyvx currently provides TV distribution services over a growing fiber network that serves some 60 cities.

In Japan, the Tokyo Telecommunications Network Company, Inc., has constructed a fiber-based system to provide telephone, data and image transmission services to business, residential and cable television programming customers.

Even the traditional rivalry between satellite and fiber distribution services has blurred as users employ the best that both technologies offer. An example in the U.S. is IDB and Vyvx pooling resources to deliver programming in the most cost-effective manner.

3. BUILDING ON AN ENTERTAINMENT FOUNDATION

The implications of these actions are startling and clear. Fiber transport will play a growing role in carrying video-based services to support an increasing variety of social, educational, cultural and economic applications. However, as we suggested earlier, entertainment will be the driver. Futurist George Gilder points out that for all of fiber's possible application in education, culture, medicine and research, the initial profits must come from the only proven market -- entertainment video.

That's why in the United States the Regional Bell Operating Companies are already building alliances with programmers and with cable system operators outside their service areas, and why the concept of convergence is applying to telco and program distribution services. And, if the U.S. district court decision survives its expected appeal, the Regional Bell Operating Companies will own programming and distribution systems within their service areas.

With entertainment fueling revenues that support infrastructure development, system operators can offer other options on their full-service networks.

Gilder describes two transport modes to support bandwidth-intensive services on these full-service networks. In the delivery of video programming such as movies, compression technology will be used not to reduce bandwidth, but to reduce the time needed to transmit the movie to the telecomputer. Full-length motion pictures can be delivered in minutes or even seconds. Alternatively, interactive services plus live news, sports and special event programming will eschew compression in favor of broadcast-quality video signals to consumer or business outlets.

4. GLOBAL APPLICATIONS

There's every reason to believe that this revolution in the concept of how communications are delivered will extend throughout the world. International transport facilities such as the North Pacific Cable and others move bandwidth-intensive services between gateways. From there, national and local fiber optic, microwave and satellite networks provide access to the end user, whether it be a household, a corporation, a hospital or an educational institution. As more and more telephony-type services move to the airwaves using digital mobile and wireless packet networks, additional bandwidth will be available on the ground to support the myriad of video and informational services envisioned by futurists such as Gilder.

We have previously alluded to applications that can be enhanced by broadband international video via fiber optic cable. At the Pan Asia Optical Fiber Summit '93 in Hong Kong, Neil Tagare spoke of medical imaging. He envisioned someone living on an island in Indonesia consulting with a medical expert in Rome via medical imaging without traveling one kilometer. This technique extends the reach of scarce medical expertise through remote diagnostics.

Another example Tagare cited is distance learning. He said that this will enable our children and grandchildren to learn from leading minds of their times -- in Tokyo University or Harvard -- right in their own classroom, whether it be in Macao or Argentina or Senegal.

Earlier, Pacific Telecom Cable, Inc., sponsored two focus groups with business leaders, asking them to envision how they'd employ international video and other services were bandwidth not a concern. As participants warmed to the topic and began to cast aside traditional thinking on how communications are delivered, interesting applications evolved.

A Japanese automotive executive envisioned a custom manufacturing scenario combining video and CAD/CAM. This would enable customers in the United States to actively participate in the "design" of their vehicle. Ashtrays, for example, could be deleted or controls placed more conveniently. Interior space could be designed around the size of customers' families instead of an average size.

Product demonstrations and employee training were mentioned. An engineering and construction executive saw video "walk throughs" of conceptual designs. As construction progresses, video could be employed to mark progress or to engineer changes in the project.

Virtually all participants agreed that broadcast quality interactive, multisite, full-motion video would greatly enhance the value and acceptability of videoconferencing.

As a final example, an entertainment executive noted that there is a definite value to the security aspects of fiber vs. satellite.

Indeed, echoing Gilder's conclusions, the focus group study concluded that entertainment programming would probably be the first application for international video services via fiber optic cable. From this will grow live one-way and interactive two-way services serving business, research and educational users.

5. AN INTERNATIONAL FEASIBILITY STUDY

As a follow-up to the focus group study, Pacific Telecom Cable participated with other entities including IDC of Japan, domestic U.S. and Japanese carriers, Tokyo Broadcasting Company and Toshiba Corporation in demonstrating fiber optic video service between the U.S. and Japan. These tests were undertaken recognizing that the global deployment of digital fiber networks will support high-quality, highly reliable video transmission services.

The first test, conducted in December 1992, was an NTSC signal loopback between Miura, Japan, and Portland, Oregon, over the North Pacific Cable (NPC). It utilized optical interface equipment developed by Toshiba/TBS and a Toshiba codec. This experiment confirmed that fiber provides high signal quality and minimum signal delay.

The second test, conducted in April 1993, was a practical demonstration of service between TBS studios in Tokyo and the Toshiba booth at the National Association of Broadcasters convention in Las Vegas, Nevada.

This test utilized Japan's Super Bird domestic satellite to carry a digital signal between TBS studios and NPC's Miura landing station because the wideband fiber link between the two locations was unavailable. At Miura, the signal was transmitted into NPC in a DS-3 (45 Mbit/s) format to comply with U.S. standards. From NPC's Portland gateway, the signal entered the U.S. domestic fiber network for routing to Las Vegas. The only change in the signal path back to Tokyo was the utilization of a microwave link between Miura and the TBS studios to minimize delay as much as possible.

At the Toshiba booth, the signal was decoded and demonstrated to NAB attendees. Demonstrations included two-way dialog between booth visitors and TBS reporters in Tokyo.

Several advantages of fiber optic service have been confirmed by these tests:

- A great reduction in transmission delay vs. satellite, which facilitates smooth dialog between participants
- High reliability under any weather conditions; no radio interruptions
- Security
- Downsizing of transmission equipment -- no antenna uplinks/downlinks
- High bandwidth, high capacity transmission.

Two factors in the success of the program include digitizing and compressing the video/audio signal up to the transmission speed of the fiber optic cable, and complying with the DS-3 format of the U.S. domestic network.

6. CONCLUSIONS AND LONG-TERM IMPLICATIONS

High bandwidth international video services via fiber optic cable are a natural progression in the evolution of telecommunications. These services are being encouraged by the proliferation of international capacity and competition-inspired reductions in the cost for broadband channels. Entertainment- related services will be the first to evolve, thereby providing the ROI for telcos, programmers and program distributors to invest in fiber infrastructure. But in the long term, educational, scientific, research and development interests will benefit.

As bandwidth intensive video-based services migrate toward high-capacity terrestrial fiber networks, radio-frequency spectrum will be used increasingly by telephony-based services including cellular radio, wireless packet data and mobile telephone/data services. Because such services can be deployed rather rapidly and require less physical plant investment than a universal wireline service, a potential solution is available to complete the "missing link" identified by the ITU. Creative utilization of all transport media will help speed realization of the goal of providing basic, then enhanced, services to a greater percentage of the world's population.

Lower Power Ku-band Direct to Home Video Broadcasting in Rainy Regions

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ABSTRACT

The effect of rain on Ku-band satellite broadcasting of analog video signals has discouraged the use of Ku-band in many tropical and semitropical regions of the world. The promise of small home antennas at Ku-band appeared to be denied in these regions. However, today new digital technologies, and recent refinements in CCIR modeling of Ku-band degradation due to rain, have changed that situation. This paper presents a top level review of how digital technology and rain modeling changes have improved the viability of direct-to-home Ku-band broadcasting in rainy regions.

1. INTRODUCTION

This paper highlights recent developments which make satellite video broadcasting to small home antennas in rainy regions practical. Changes in the analytical modeling of satellite signal attenuation have reduced the predicted attenuation in heavy rain areas of the world. In addition, low cost digital home receivers are now available which can accept the low signal levels resulting after attenuation by heavy rain. The rain model changes, and the new digital signal technology, combine to make Ku-band broadcasting in rainy regions practical today. The expensive high power satellites that made this satellite service impractical for many nations, particularly in rainy regions, are no longer required. Today, direct-to-home satellite (DTH) broadcasting of many video channels can use a small inexpensive satellite. The home receivers, which adapt the satellite signal to current analog television sets, will be priced at less than half the price of the current analog receivers. The resulting price reductions in both the satellite and home receivers should lead to affordable direct-to-home video broadcasting in developing nations, even when these nations are in very rainy regions.

This paper addresses the following two subjects which dramatically lower the satellite power and thereby cost of satellite direct-to-home broadcasting in rainy regions:

1) Reduced rain attenuation indicated by the latest CCIR rain model issued in 1990.
2) Power and spectrum efficiency advantages of the new low cost digital technology.

Section 2 describes typical characteristics and service availability requirements as design points for comparing old and new rain models and technology advances. Section 3 describes the effect of rain model changes on Ku-band rain attenuation, and Section 4 describse the impact of digital technology on the amount of receive power required. Both changes contribute to a large reduction in the satellite power needed per channel of DTH service. Section 5 summarizes the impact on DTH satellite broadcast payloads by presenting some typical examples.

2. SERVICE AVAILABILITY AND DESIGN CRITERIA

The design parameters selected as examples are:

Frequency	12.5 GHz
Polarization	Linear, horizontal
Rain regions	N and P
Availability requirement	2 cases, 99.00% and 99.50% worst-case month availability
Home antenna size	2 cases, 50 cm and 75 cm diameter circular aperture

The frequency and polarization selected are typical of that used if the payload shared an FSS orbit slot and/or had multinational coverage not permitted in the broadcast satellite service (BSS) frequency band. The differences resulting from using other Ku-band frequencies and polarizations would be minimal.

The two availabilities picked represent typical values that a system designer might select. Table 1 shows the worst-case month and the corresponding average annual availabilities determined by using equations recommended by the Consultative Committee on International Radio (CCIR). The 99.77% average annual availability corresponds to the CCIR guideline of no more than 1% outage in the worst-case month. The higher availability example was selected arbitrarily to provide 50% less outage during the worst-case month than the CCIR recommendation. The success of the SES ASTRA direct broadcast system in Europe indicates that a system designed according to the CCIR guideline, or slightly better, is acceptable to the public.

TABLE 1. SERVICE AVAILABILITY DESIGN CRITERIA

Rain Outage Design Criteria	Availability and Outages Allowed			
	Worst-case Month		Average Annual	
	Availa-bility, %	Outage*, min/mo.	Availa-bility, %	Outage*, min/mo.
CCIR Guideline Outage	99.00	432	99.77	99
50% Better than CCIR Guideline	99.50	216	99.90	43

*Total accumulated time with typical individual outage being only a few minutes.

Other design parameters could have been selected, but it is believed that these are realistic and will serve adequately to meet the objectives of this paper to highlight the improved viability of direct-to-home Ku-band satellite broadcasting in rainy regions.

3. IMPACT OF THE NEW 1990 CCIR RAIN MODEL

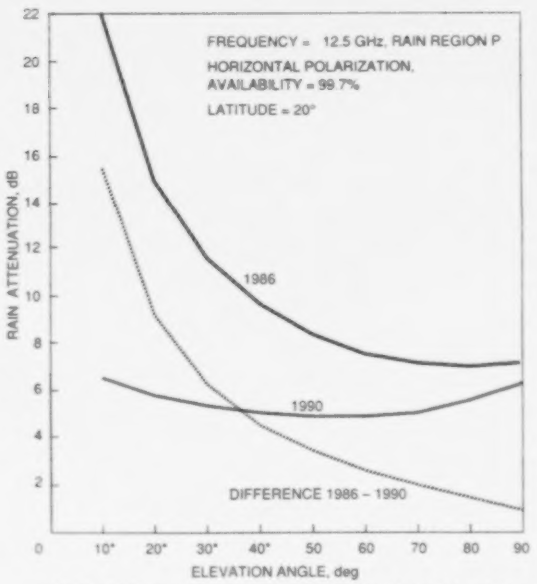
The CCIR periodically makes recommendations for technical planning of radio communications systems. Among its functions is the revision of a widely used rain attenuation prediction algorithm, known as the "CCIR Rain Model", based on theory and propagation measurements from terrestrial and space RF links. The most recent CCIR Rain Model (1990) incorporated two important revisions to the previous (1986) model which resulted in significantly lower rain attenuation predictions, especially in tropical regions. Table 2 shows the rain attenuation prediction for both of these example design parameters and two latitudes. The predicted reduction in rain attenuation shown in the last column is very large. The two key modifications to the 1990 CCIR rain fade prediction formula are: 1) a reduction of effective rain height in equatorial latitudes, and 2) a reduction of rain cell density in the horizontal direction at high rain rates. The net consequence of these modeling changes is a significant decrease in effective path length over which the rain attenuation is computed for slant path satellite to earth Ku-band links in tropical regions.

TABLE 2. COMPARISON OF OLD AND NEW RAIN MODELS

Rain Region	Latitude, deg	Average Annual Availability, %	Rain Attenuation, dB		
			'86 Model	'90 Model	Change
N	0	99.77	5.69	3.78	-1.91
	0	99.90	8.45	5.62	-2.84
	20	99.77	5.69	4.30	-1.39
	20	99.90	8.45	6.39	-2.06
P	0	99.77	9.45	5.00	-4.45
	0	99.90	14.04	7.42	-6.62
	20	99.77	9.45	5.53	-3.92
	20	99.90	14.04	8.21	-5.83

Conditions:

1) 50° antenna elevation angle
2) 12.5 GHz



*ACCURACY BELOW 50° IN QUESTION BASED ON INTELSAT DATA

FIGURE 1. RAIN ATTENUATION VERSUS ELEVATION ANGLE

Another important implication of the newer CCIR Rain Model concerns the behavior of predicted rain attenuation versus elevation angle. Intuitively, one would expect that the rain fade would monotonically worsen with decreasing elevation angle. However, because of a modification on the rain cell spatial distribution model, the 1990 algorithm predicts a minimum rain fade away from the 90° directly over-head elevation. Figure 1 shows an example of rain attenuation variation with elevation angle. In this typical example, minimum attenuation is reached at an elevation angle of 50° and the change over the range from 90° to 10° elevation is small. However, recent INTELSAT measurements of rain attenuation at Ku-band (1) cast doubt on the accuracy of the 1990 CCIR Rain Model at low elevation angles. For this reason, the elevation angles considered in this paper will be 50° or above. Since the regions of interest in this paper are at low latitudes, high elevation angles are easily achieved and the 50° elevation angle does not seriously limit the application of the results presented.

4. IMPACT OF DIGITAL TECHNOLOGY

Advantages of Digital Transmission

The success of modern digital video transmission systems relies on a synergistic combination of two distinct signal transformations: *source coding* (data compression) and *channel coding* (error-correction capability). The theoretical basis for both of these techniques have their origins in Shannon's information theory developed in the 1940s. However, their practical implementation in low cost consumer products has been feasible only recently using VLSI electronics. These technological advances can be applied

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efficiently and economically to distribute hundreds of video signals over a wide coverage area using low cost home receiving systems.

The fundamental advantage of digital signal transmission over conventional analog methods is that the originating signal may be processed efficiently to transmit the minimum data necessary over a noisy channel so the source material can be reconstructed with good fidelity at the destination. Data processing at the transmitting end minimizes the power and bandwidth resources of the communications link used to convey the information. The flexibility inherent in digital techniques allows the exploitation of two powerful signal processing operations: source coding to reduce the transmission data rate and channel coding to make the received signal more resilient against noise and other interferences. Source coding (data compression) essentially removes redundant information from the original video signal by transmitting mostly differential data (i.e., data with high informational entropy). This compaction minimizes the spectral occupancy of the baseband signal. On the other hand, channel coding adds structured redundancy in the data stream either to reduce the number of channel-induced errors, or to maintain the desired error rate with a lower receive power level. This error-correction coding deliberately expands the transmitted bandwidth beyond the minimum required by the source coding.

The quantitative effect of both of these digital coding methods can be seen by examining the basic relation between receive signal power and signal energy:

$$P_r = E_b * R_i$$

where P_r = received signal power (watts)

E_b = energy per bit (joules/bit)

R_i = information data rate (bits/sec)

The data compression reduces the required transmitted information data rate, R_i, from the original source rate. The channel coding effectively lowers the minimum bit energy, E_b, required for a specified quality (bit error rate) in a given noise environment. The combination of these two reductions can greatly lower the minimum receive signal power resource, P_r, necessary for a desired communications performance. In addition, the transmission bandwidth needed, which is directly proportional to the data rate, is reduced compared to analog methods.

An important question in all digital compression methods is how small the data rate can be to provide an acceptable quality to the end user. This is an open research area since no simple quantitative criterion for the minimum data rate for a given application can be stated. However, from the available literature, it appears that for equivalent standard (e.g., NTSC, PAL, or SECAM) television quality, a compressed video average data rate of about 5 Mb/s is reasonable. For a standard resolution television display, this rate corresponds approximately to an informational entropy of 1 bit per pixel per frame. Ultimately, adequacy of the compressed data rate can only be evaluated through subjective viewer testing.

It is important to note that the perceived quality at a given rate is highly dependent on the source content. Obviously, a rapidly varying scene (e.g., sports telecast) will not be reproduced as well as a scene with quasi-static content (e.g. business video conferencing) transmitted at the same data rate. Therefore, a variable bit rate source encoding scheme should be used, if possible, to adapt the data stream to the signal dynamics. The peak rate per video source channel could then be greater than its average rate. This adaptability can be most effectively implemented in a statistical multiplexer in the source encoder where several video channels are brought together into a single data stream with a fixed output rate. In this case, the individual peak data rates would average out for a more efficient data transmission.

In the link analysis below the compressed digital television system is assumed to use time division multiplexing (TDM) to combine multiple video signals at the uplink site onto a single RF carrier per satellite transponder. Each compressed video channel is assumed to require 5 Mb/s average data rate for adequate quality.

Comparison of Analog FM and Compressed Digital DTH Link Requirements

For an objective comparison between conventional analog FM transmission and the newer compressed digital video systems, we show here some typical results for a satellite direct-to-home television broadcasting application using Ku-band FSS frequencies. We assume that very small home receiving antennas are required, both to minimize the consumer cost and to simplify siting and aesthetic concerns. The system is sized to provide reasonable service availability in tropical climates and in the presence of adjacent satellite interferences. The performance metric used to compare the various broadcasting techniques is the minimum satellite transponder EIRP (dBW) needed to close the link, i.e., provide at least some positive margin against the appropriate carrier/noise threshold for proper functioning.

Rain Attenuation

For purposes of illustration, the tropical regions examined here are confined to CCIR rain regions N and P which represent the most severe Ku-band propagation environments in the world. The ground site is assumed to be at the equator and sea level altitude, and the elevation angle to the desired satellite is set to 50°. The RF carrier at 12.5 GHz frequency is assumed to have horizontal linear polarization since this yields the worst-case copolarized rain attenuation predictions using the CCIR global rain model. Two worst-month availabilities are analyzed: 99.0% which is the CCIR recommendation for satellite broadcasting, and 99.5%, for improved service and/or link quality. The rain fade for each of these conditions is predicted using the latest available CCIR (1990) algorithm,(2) and the results are shown in Tables 3 and 4.

It is worth recalling here that the effect of rain fade on the satellite downlink is worse than just the signal attenuation loss effect. With present day Ku-band low noise receivers, the effective antenna external noise temperature is a significant contributor to the total thermal noise level. As the required availability increases, the increased rain attenuation also results in excess thermal noise contribution beyond that of the clear sky condition. For tropical climates, this extra link degradation can be several decibels. Thus, the penalty in terms of power or aperture requirements for low outage Ku band systems can be quite severe.

Adjacent Satellite Interference Model

Because of the very small apertures assumed in the home terminal, the sensitivity of the Ku-band link to adjacent satellite interferences is an important issue. In general, this a difficult modeling problem due to uncertainties in the interference environment and because of the different types of signal parameters (modulation, center frequency, bandwidth, etc) to be analyzed. A simple model is used here to characterize the main features of the interference sensitivity.

The satellite downlink is assumed to be contaminated by interferences from four adjacent satellites located -4°, -2°, +2°, and +4°, respectively, off the ground receive antenna boresight. Each interfering satellite illuminates the home aperture with an EIRP of 45 dBW over the same bandwidth as the desired satellite. In this case, the only rejection obtained by the home terminal is through the angular discrimination of its receiving antenna pattern. The recommended pattern function for small (less than 100 wavelengths) diameter apertures from the Radio Regulations (1990) Appendix 29, Annex II is used to model the home antenna gain off boresight. The downlink carrier/interference ratio is then simply given by the ratio of desired satellite EIRP to the weighted sum of interfering satellite EIRPs.

Uplink Model

For both analog and digital transmission examples, the same uplink ground station size is used to generate the required satellite transponder input carrier level. A 2 kW ground transmitter and 7 meter diameter antenna at 14 GHz yields approximately 25 dB uplink carrier/noise ratio with up to 10 dB uplink rain fade. Either uplink power control or satellite automatic gain control is needed to ensure that the satellite transponder remains in output saturation during rain fade events.

Note that for the multiplexed digital transmission case the compressed video channels are combined at the uplink site and modulated onto a single TDM carrier per transponder for maximum power and spectrum efficiency. This implies that the various sources of video material must be delivered from the originating site to the satellite uplink station via terrestrial or multiple access satellite means.

Modulation and Video Quality Parameters

For the analog transmission system conventional FM methods are assumed. The satellite transponder bandwidth is taken as 27 MHz so that an FM improvement factor of 35 dB (including pre-emphasis and noise weighting gains) may be obtained with a video baseband of approximately 5 MHz. A carrier/noise threshold requirement of 10 dB (over the RF bandwidth of 27 MHz) is assumed, such that the resultant peak signal/weighted noise ratio of 45 dB delivered to the home television receiver is attained, in accordance with CCIR recommendations for direct-to-home broadcasting.

It is not obvious what the compressed digital video transmission scheme should be to make a fair comparison with the above FM system. However, as noted earlier, we assume an average information rate of 5 Mb/s is needed per video channel to achieve standard broadcast quality video. Then, the channel coding method must be selected to minimize the power requirements on the link, but also have a practical implementation for consumer products. Recent advances in digital electronics allow the use of sophisticated, real time error correction coding and decoding methods at video signal rates to greatly reduce the required carrier/noise threshold requirements on the satellite link at a reasonable cost. There are digital systems today being developed which make use of powerful concatenated channel codes to reduce the required bit energy dramatically for a very low bit error rate (around 10^{-10} BER). The E_b/N_o (information bit energy/noise density ratio) threshold for these types of concatenated codes is around 5 dB with an effective code rate of around 0.6 (information bits/transmitted bits). With shaped QPSK signaling, this modulation results in an RF bandwidth of about 6 MHz per video channel.

Results of Link Analysis

The above assumptions were used to tabulate the minimum required satellite EIRP (per transponder) at the appropriate threshold, for two small dish sizes: 50 cm and 75 cm diameter. An aperture efficiency of 60% is used and a system noise temperature of 120 K is assumed for clear sky conditions. The results are tabulated for three cases: single video channel using an analog FM carrier, single video channel using a compressed digital carrier, and four multiplexed video channels using a compressed digital carrier. The comparisons for a 50 cm aperture is summarized in Table 3 and for a 75 cm aperture in Table 4.

TABLE 3. MINIMUM SATELLITE EIRP
FOR 50 cm DIAMETER APERTURE

CCIR Rain Region	Worst Month Avail, %	Rain Fade, dB	Analog FM EIRP, dBW	1 Digital Channel EIRP, dBW	4 Digital Channels EIRP, dBW
N	99.0	3.8	58.6	50.6	53.0
N	99.5	5.6	60.2	51.4	54.6
P	99.0	5.0	59.7	51.1	54.0
P	99.5	7.4	61.9	52.4	56.2

TABLE 4. MINIMUM SATELLITE EIRP
FOR 75 cm DIAMETER APERTURE

CCIR Rain Region	Worst Month Avail, %	Rain Fade, dB	Analog FM EIRP, dBW	1 Digital Channel EIRP, dBW	4 Digital Channels EIRP, dBW
N	99.0	3.8	54.6	46.0	48.9
N	99.5	5.6	56.4	47.0	50.6
P	99.0	5.0	55.8	46.7	50.1
P	99.5	7.4	58.2	48.2	52.4

Sample link budgets using a 50 cm home terminal in Region P with a worst-month availability of 99.0% for the analog FM case and for the compressed digital case are illustrated in Tables 5 and 6 respectively.

A comparison of this case shows that in the same rain and adjacent satellite interference environment, with approximately the same viewer quality requirements, and using the same home terminal RF characteristics, *the compressed digital transmission system can deliver four multiplexed video channels per transponder at nearly 6 dB less satellite EIRP than the conventional FM transmission system with one video channel per transponder*. The impressive 12 dB gain (i.e., 6 dB lower EIRP plus 6 dB more channels) of the digital system is due to the dramatic reduction of bandwidth from the video compression, the reduction in signal/noise threshold requirements from the sophisticated error-correction coding, and the power and spectral efficiency of statistical multiplexing of several video channels onto one data stream. In addition, the digital system is more tolerant of interference because of the very low threshold, and uses less RF transmission bandwidth per video channel because of the video compression rate reduction.

Another important advantage of digital transmission is that with its lower satellite EIRP requirements and more even energy spectral distribution, it is far easier to comply with the Radio Regulations power flux density restrictions in the Ku FSS band. In contrast, the analog FM system using an EIRP of around 60 dBW would require a significant energy dispersal bandwidth (greater than 10 MHz).

TABLE 5. ANALOG FM TV LINK ANALYSIS

Downlink Parameters	
No. of channels per carrier	1
Satellite EIRP, dBW	59.7
Satellite EIRP density, dBW/Hz	-14.6
Power split, dB	0.0
Output backoff, dB	0.0
Downlink wavelength, m	0.0240
Downlink space loss, dB	-205.76
Downlink clear sky loss, dB	-0.5
Downlink rain loss, dB	-5.00
Ground antenna mean diameter, cm	50.0
Ground antenna azimuth beamwidth, deg	3.36
Ground station downlink pointing error, deg	0.10
Ground antenna efficiency	0.60
Ground antenna gain, dB	34.10
Ground downlink pointing loss, dB	-0.01
Received carrier power, dBW	-117.47
Clear sky noise temperature, K	120.0
Extra noise due to rain, K	198.3
Total downlink noise temperature, dB-K	25.0
Ground receive G/T, dB/K	9.1
Downlink thermal C/No, dB-Hz	86.1
Downlink thermal C/N, dB	11.8
Link Summary	1
Uplink thermal carrier/noise, dB	24.9
Downlink thermal carrier/noise, dB	11.8
Carrier/intermodulation, dB	100.0
C/I adjacent satellite interference, dB	15.4
Total C/N ratio, dB	10.1
Link Margin, dB	0.07

TABLE 6. DIGITAL COMPRESSED TV LINK ANALYSIS

Downlink parameters			
No. of channels per carrier	4	2	1
Satellite EIRP, dBW	51.1	51.1	51.1
Satellite EIRP density, dBW/Hz	-22.5	-19.6	-16.7
Power split, dB	0.0	0.0	0.0
Output backoff, dB	0.0	0.0	0.0
Downlink wavelength, m	0.0240	0.0240	0.0240
Downlink space loss, dB	-205.76	-205.76	-205.76
Downlink clear sky loss, dB	-0.5	-0.5	-0.5
Downlink rain loss, dB	-5.00	-5.00	-5.00
Ground antenna mean diameter, cm	50.0	50.0	50.0
Ground antenna azimuth beamwidth, deg	3.36	3.36	3.36
Ground station downlink pointing error, deg	0.10	0.10	0.10
Ground antenna efficiency	0.60	0.60	0.60
Ground antenna gain, dB	34.10	34.10	34.10
Ground downlink pointing loss, dB	-0.01	-0.01	-0.01
Received carrier power, dBW	-126.07	-126.07	-126.07
Clear sky noise temperature, K	120.0	120.0	120.0
Extra noise due to rain, K	198.3	198.3	198.3
Total downlink noise temperature, dB-K	25.0	25.0	25.0
Ground receive G/T, dB/K	9.1	9.1	9.1
Downlink thermal C/No, dB-Hz	77.5	77.5	77.5
Downlink thermal C/N, dB	3.9	6.8	9.7
Link Summary	4	2	1
Uplink thermal carrier/noise, dB	25.6	28.6	31.4
Downlink thermal carrier/noise, dB	3.9	6.8	9.7
Carrier/intermodulation, dB	100.0	100.0	100.0
C/I adjacent satellite interference, dB	6.8	6.8	6.8
Total C/N ratio, dB	2.1	3.8	5.0
Link Margin, dB	-2.86	-1.17	0.02

5. SATELLITE PAYLOAD EXAMPLES AND CONCLUSIONS

Two example satellite broadcast payloads (Tables 7 and 8) are sized below to illustrate the benefits of rain attenuation reduction and advances in digital technology. The first example is based on an existing Ku-band payload scheduled for launch in late 1993 for Thailand. The other is a hypothetical payload sized for Malaysia.

Each THAICOM satellite will provide ten C-band transponders for regional communications services and two Ku-band transponders. The business plan for THAICOM's two Ku-band transponders is not known by the authors so the DTH system described below is simply an example of what could be done and not necessarily what is planned. THAICOM uses the Hughes HS 376 spin stabilized satellite in a "lightsat" HS 376L configuration permitting a low cost shared Ariane launch. The Ku-band payload covers Thailand with a minimum EIRP of 50 dBW. THAICOM's Ku-band payload uses 47 watt traveling wave tube amplifiers, which use less than half the total payload power.

Thailand lies primarily in rain region N. The THAICOM 1 orbit slot of 78.5°E is assumed, giving an elevation angle range over Thailand from 55° to 86°. The higher elevation angle and the highest latitude reached in Thailand, 21°N, are used in the 1990 CCIR rain model since they produce the worst-case rain attenuation. A 75 cm diameter home antenna and the CCIR availability guideline of 1% in the worst-case month are used. When the analysis techniques described in Section 4 are used with this input data, the 50 dBW EIRP is found to be adequate for 4 digital video signals per transponder. An analog video signal under the same conditions would require an EIRP of 55 dBW, well beyond that provided by THAICOM. Using the 1986 rain model and analog transmission, a DTH service would be impossible since an EIRP of 56 dBW would be required for the same availability and home antenna size.

THAICOM is a perfect example of how a small broadcast payload can provide a good 8 channel DTH service in a rainy region. The DTH broadcast payload is small and shares a small satellite with another major revenue producing payload. The economics of this situation are obviously much better than the high power dedicated direct broadcast satellite that would have been considered necessary only a few years ago for this class of service.

The rain attenuation and payload for both examples are summarized in Tables 6 and 7. The Malaysia example is hypothetical and is not necessarily being considered. In the Malaysian example, a standard HS 376 spacecraft is used to provide the larger C-band payload as well as the two transponder DTH payload. In each example, the EIRP required with the old CCIR rain model and analog transmission are shown for comparison.

The example payloads assume the adjacent satellite interference model described in Section 4 (i.e., four satellites with 2° separation and 45 dBW EIRP each). If the interference were higher, for example at 50 dBW, there would be an impact on the example payloads described. The 75 cm home antenna used in the THAICOM example would need to be increased to 87 cm to receive the same 8 channel service. In the Malaysia example, the Ku-band amplifier power would be increased to 75 watts, which is well within the capability of the spacecraft electrical power system. Digital transmission is relatively insensitive to adjacent satellite interference, making it possible for small changes in EIRP or antenna size to provide very large increases in protection from adjacent satellite interference. In these two examples an increase of 5 dB in each of four interfering signals was compensated for by only a 2 dB improvement in the broadcast link.

TABLE 7. RAIN ATTENUATION FOR DTH BROADCAST SERVICE

Example and Coverage	Rain Region	Frequency, GHz	Orbit Slot	Elevation Angles	Highest Latitude	Rain Attenuation CCIR rain model	
						1990	1986
Thailand	N	12.5	78.5°E	55° to 86°	21°	4.20	5.39
Malaysia	P	12.5	91.5°E	56° to 77°	7°	5.56	7.92

Conditions:

1) Worst-case elevation and latitude
2) CCIR guideline of 1% maximum outage in worst-case month

TABLE 8. EXAMPLE DTH VIDEO BROADCAST PAYLOADS

Example Service Area	Satellite and Transponders	Ku-band Amplifier Power, W	EIRP Needed in dBW Channels per Transponder 1990 CCIR Rain Model		
			4 Digital	1 Analog	1 Analog
Thailand	HS 376L with 10 C-band and 2 Ku-band transponders	47	49.3	55.1	56.1
Malaysia	HS 376 with 18 C-band and 2 Ku-band transponders	50	50.4	56.1	58.4

Conditions:

1) Home antenna diameter is 75 cm
2) CCIR guideline of 1% maximum outage in worst-case month
3) Satellite sized for 8 digital channels (2 Ku transponder) and C-band payload, with EIRP needed for analog shown for comparison only

Higher availability DTH service could also be provided. Tables 7 and 8 are based on the CCIR guideline of no more than 1% outage in the worst-case month. As mentioned in Section 2, this seems to be an acceptable outage level to the public in at least one very successful satellite direct broadcast system. However, if a higher availability were desired, such as the 0.5% worst-case month outage suggested in Section 2, it could be provided by either increasing the home antenna size or the EIRP shown in Table 8. In the THAICOM example where the payload is already built the home antenna size would be increased in diameter. An increase from 75 cm to 95 cm would provide the desired 50% reduction in outage. In the Malaysia example, where the payload is not yet built, the EIRP could be increased by 2.5 dB. The 90 watt amplifiers required to increase the EIRP in Malaysia would still fit within the power constraints of the satellite bus.

Only a few years ago, the EIRP levels shown in the last column of Table 7 were considered necessary. These EIRP levels would have required a dedicated satellite that could provide only two or three DTH channels. Those dedicated satellites appeared expensive and had a low revenue potential and consequently very few national systems were ever built. The situation is changed through a better understanding of rain attenuation at Ku-band and the advances made in developing low cost digital signal processing. Practical Ku-band DTH satellite broadcast systems are possible today in rainy regions where they were considered impractical a few years ago.

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NOTES

PERSONAL COMMUNICATIONS:
PERSPECTIVES, FORECASTS, AND INSIGHTS

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Abstract

We present a model for forecasting the number of subscribers, price, digital technology adoption, and wireline revenue impact for personal communications on cellular and Personal Communications Network (PCN) architectures. Specific forecasts for the United States are presented, along with their implications. However, the general modeling and forecasting approaches should have broader application.

We concluded that both cellular carriers and traditional wireline carriers can compete in a personal communications environment. However, modernization of network equipment is a must. For wireline carriers, a more realistic valuation of the lives for copper distribution cable is also recommended.

The concept of personal communications has caused as much excitement, confusion, and fear as any other recent development in telecommunications:

- *Excitement* over the prospect of an economical, intelligent, and portable communications system.
- *Confusion* over terminology for overlapping technologies, capabilities, and services.
- *Fear* about the impact on the landline telephone network.

Each of these emotions are, at least partially, justified. Our job is to sort out some of the key issues and provide a dispassionate forecast regarding the timing and magnitude of probable changes.

As generally understood, personal communications provide at least the following:

- Tetherless communication with a high level of portability, at least as high as today's cordless and portable cellular phones.
- System capacity and coverage to eventually serve everyone.
- A price low enough to encourage mass usage.
- A personal number that allows a person to be reached no matter where the person is located.
- Quality and reliability at least commensurate with today's cellular service.
- Intelligent features that allow the user control over who can reach him—and when and where—along with integrated voice mail, data, and fax capabilities.

Today, we have communications services that provide at least some of these things; however, there is no single package that provides them all. Therein lies the excitement about personal communications: It provides the integration of a number of characteristics that have already been market-proven, and it appears technologically feasible. Not to mention that it is a culmination of a dream that has been encoded into our psyches by youthful visions of Dick Tracy.

The confusion over terminology is perhaps natural when so many capabilities—and players who would like to offer them—are involved. In the United States, the terms Personal Communications Network (PCN) and Personal Communications Service (PCS) have come to refer to wireless services that will operate in the 1.8 GHz to 2.0 GHz radio frequency band using microcells and digital CDMA technology. However, cellular radio, operating in the 800 MHz to 900 MHz band, already meets some of the requirements of our definition of personal communications and, through normal technological and business evolution, will likely meet all of them in the future. Personal numbers and intelligent features have been touted as a cornerstone for personal communications, but are based on technological capabilities that were originally designed for—and are being implemented on—the landline phone network. Finally, for many years, personal communications will be dependent on the wireline network to reach those people without portable devices.

Exhibit 1 summarizes the features of personal communications and the ability of each type of network to deliver them. The table is important because it encapsulates the assumptions behind our conclusions, namely:

- To the customer, personal communications is the handset and the characteristics listed in the table. The customer could care less about the technology in the network.

- Whatever distinctions among the technologies used by cellular and PCN carriers survive in the future, they are unlikely to make a fundamental difference in the delivery of the characteristics customers care about. Thus, we use the term cellular/PCN to refer to both types of networks jointly.

- Existing trends and relationships in prices and subscriber levels for wireless communications will continue, with personal communications evolving to a low-price mass market. If this does not happen on its own, the introduction of additional competition through PCN licensees will make it happen.

- Through digitization, cellular networks will be able to handle their share of the personal communications market.

For local exchange carriers (LECs), the fear is that personal communications will cause reduced revenues and lost customers. Once another supplier can provide a complete personal communications package as outlined above (including low prices), the LECs will be at a competitive disadvantage, because they cannot effectively offer portability with their existing wireline networks. In the United States, the move by AT&T to acquire McCaw Cellular Communications did nothing to quell these fears. (Potentially, McCaw customers will be able to bypass the local exchange to reach AT&T, depriving the local exchange of access charge revenues which comprise about a quarter of their revenues.)

The weak link for the LECs is the copper distribution portion of their networks. The remaining portions of their networks are useful (or will be useful, after modernization) in a personal communications environment. These portions include fiber feeder and interoffice facilities, digital switches, and platforms providing network intelligence and control. Thus, it is only the copper distribution network that is necessarily made obsolete by advances in wireless communications. However, unless the LECs have a way to acquire wireless access themselves, their entire network investment is in jeopardy.

Competition in the local loop will continue to increase and, over the next 20 years, we will likely evolve to a situation where there is more than one provider for every network function, including voice access, broadband access (via fiber and/or coaxial cable), local switching of all types, and interoffice transport. Although the ultimate industry structure and business relationships are far from clear now, we assume that:

(1) LECs will be given a fair chance to compete.

(2) They will undertake the modernization of the networks required to compete fairly.

These assumptions are not required for most of our conclusions, but they allow us to focus on the impact on the LECs' copper distribution plant. If these assumptions prove wrong, the impact on the LECs will spread well beyond the distribution network. In addition to the threat from wireless, copper distribution facilities are also being attacked from two other sides. Fiber optics is making copper technologically obsolete for all types of telecommunications services. Second, the cable television industry is gearing up to provide direct access competition, over a combination of fiber optics and coaxial cable, for both interactive video and voice services.

Our approach to measuring the impact is based on assessing revenue losses due to wireless competition. Since these losses will depend, in part, on wireless prices and subscriber levels, we will first discuss forecasts of these.

Cellular/PCN Prices and Subscribers

From 1984 through 1992, cellular prices in constant dollars have declined an average of 22% per year for the handset and 10.5% per year for service. In the future, we see handset prices, which on a monthly basis are already low, approaching a lower limit. In the absence of a major change in the driving forces for carrier service pricing, we expect that the established rates of decline will continue. (The most credible potential driving force change is the introduction of additional competition through PCN licensees.) As illustrated in Exhibit 2, this implies that carrier charges that now average $80 to $90 for a customer using 250 minutes of prime-time service per month will average under $31 (in 1992 dollars) in the year 2001. This trend in carrier charges implies that average airtime charges would fall to under $0.10 per minute by the year 2003.

Our "low-demand" forecast for cellular/PCN subscriber demand assumes that the price trends outlined above continue and that the historical price-demand relationship holds. We expect the 10 million U.S. cellular subscribers in 1992 to grow to 38 million by the year 2001. We call this our "low demand" scenario for cellular/PCN subscribers because it is more likely to understate demand than overstate it. The reason is prior forecasts using the same basic methodologies (but with less data) have underestimated the demand that actually developed.

If carrier charges are reduced faster than normal or if customers assign much greater value to mobility than is currently evident, U.S. subscribership of over 100 million by the year 2001 could be obtained. This high-demand scenario, although unlikely based on current evidence, needs to be seriously considered, and a lookout for factors supporting it should be maintained. The historical and forecast data for the two scenarios are shown in Exhibit 3.

In our discussion of prices and subscriber demand, we have not drawn a distinction between PCN and cellular service. This is consistent with our assumption that, from the customer's perspective, personal communications is independent of the underlying technology. Since any significant penetration of PCN is unlikely before 1995, there is perilously little data on which to base a separate PCN forecast. We have examined possible scenarios for anywhere from 8 million to 67 million PCN users by 2001. The lower value, which we find the most credible, assumes that PCN penetrates the market at the same rate cellular did. The higher value assumes a high-demand scenario for personal communications and that PCN captures the bulk of the additional subscribers.

A separate forecast for personal communications (whether delivered on cellular or PCN frequencies) as opposed to "plain-old cellular service" is also problematical, but for a different reason. Given all the elements that make up our working definition of personal communications, it is not clear exactly when a service stops becoming "plain" and indeed becomes "personal." The transition being evolutionary and multi-dimensioned, we feel it is best to forecast the individual elementsÍprice, subscribership, portability, personal numbers, intelligence, etc.—and not attempt an integrated forecast. However, we can safely say that, by the year 2001, cellular and PCN service will be much more personal than today and that, as stated, there will be at least 38 million subscribers in the United States.

Impact on the Local Exchange Network

With forecasts of cellular/PCN prices and subscribers, we can estimate the likely impact on the local exchange network. As already discussed, we will limit focus on the weak link—the copper distribution facilities. Again, the remainder of the LEC network retains its usefulness for personal communications, if modernization continues and LECs are allowed to compete fairly.

The potential impact comes in two forms, and the first impact is likely to come well before the second:

(1) Reduced usage of wireline telephones leading to reductions in usage-sensitive revenues.

(2) Abandonment of wireline connections altogether, leading to reductions in monthly revenues.

As prices fall, cellular/PCN customers become indifferent to making a call on a wireline phone or a cellular phone in more situations. Further, as cellular becomes more portable (and more personal in general), there will be more situations in which the average subscriber has the opportunity to use it. Finally, as subscribership grows, so does the absolute number of people that have the opportunity to make and receive cellular/PCN calls.

Since about half of U.S. LEC revenues are usage sensitive, the potential threat is large. About half of the usage revenue comes from access charges paid by inter-LATA carriers, e.g., AT&T, MCI, and Sprint. An LEC loses a portion of this revenue every time a cellular call is originated (or terminated) on a cellular phone (assuming direct cellular access to the long-distance carrier). The remainder of the usage revenue comes from intra-LATA toll, coin, measured service, and cellular access charges. The first three types of revenue are lost every time a caller uses a cellular phone to place a call instead of a landline phone. Intra-LATA toll and coin calls are, in fact, calls that a cellular subscriber are most likely to use the cellular phone to make, since for those calls, the cost differential is less significant. Cellular access charges, on the other hand, may actually increase LEC revenues—temporarily, at least. When a cellular subscriber calls a wireline subscriber (or vice versa), the LEC receives an access charge from the cellular carrier. Since local wireline-to-wireline calls are often free, the LEC may receive revenue it would not have otherwise received. On the other hand, once cellular/PCN subscribership reaches a point where cellular-to-cellular calls become common, these revenues will also be lost.

Non-usage-sensitive revenues are safer, because it will be many years before many wireline phones are completely abandoned. However, once wireless prices fall to the point where a majority of calls are made on the cellular phone, the temptation to forego the wireline monthly charge will grow. At some point, whatever residual cost penalties remain for using cellular/PCN may be outweighed by the expense of paying two monthly charges. Base-station phones will retain some usefulness in providing for general calls to a residence or business instead of a person. However, in the long run, there is no reason the base station cannot be a cellular phone also.

From the above discussion, one can see that the impact on wireline revenues will be very complicated. In spite of this, we have created a simple model that combines our price and revenue forecasts with assumptions about consumer behavior to estimate the potential landline revenue impact. Exhibit 4 shows the projected impact per access line on revenues and net cash flow from wireless access. We estimate that even a low demand scenario for wireless competition would lower LEC annual revenues by 4% in 2001 and 15% by 2011, holding everything else equal. However, revenue from other services—including wireless services, wideband and broadband digital services, and network services to other carriers—have the potential to make up the shortfall.

Nevertheless, copper distribution facilities will have a minimal role in providing these offsetting new revenues.

One measurement of the value of an asset is the Net Present Value of its future cash flows. If we assume that the revenue-generating potential of the copper distribution investment declines in the proportion forecast above and that operating costs for maintaining the copper plant stay about the same, we can estimate the decline in future cash flows over time. Based on this type of analysis, we estimate that the value of copper distribution facilities will fall by at least 23% by 1997, 61% by 2002, and 92% by 2010. Thus, although the revenue impacts of cellular competition are minimal before the year 2001, the impacts on the value of the LEC copper-based investment occurs much earlier.

This likely decrease in value is grossly inconsistent with current regulated depreciation schedules in the United States and other countries for copper investment. Previous forecasts of the replacement of copper by fiber optics already suggest much lower lives for copper cable than currently used. Adding the impact of revenue lost to wireless competition only exacerbates the problem. For most U.S. LECs, average remaining lives of 12 to 20 years are used for copper distribution cable in most jurisdictions. However, we conclude that, in a competitive environment, the average remaining life for copper distribution facilities should be 7.3 and 8.8 years, depending on whether a low-demand or high-demand scenario is chosen for cellular/PCN demand. Exhibit 5 shows the net present value and depreciation analyses for the low-demand scenario.

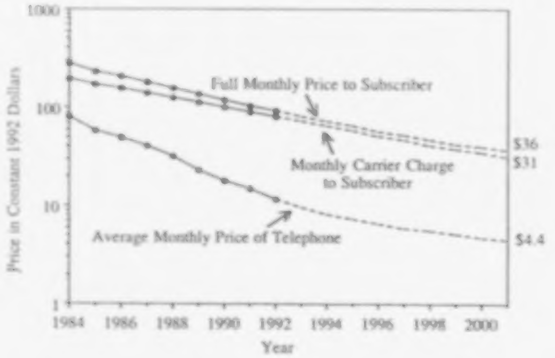
The implication should not be that the LECs have a limited future. On the contrary, they have tremendous strengths in know-how, financial resources, people, market recognition, operations, and their local networks. With continued modernization in digital switching, fiber optics, intelligent network infrastructure, and wireless technologies, they should be able to compete effectively in the world of personal communications.

Exhibit 1
Features of Personal Communications

	Wireline		*Cellular*		*PCN*	
Feature	**Now**	**Future**	**Now**	**Future**	**Now**	**Future**
Tetherless	No	No	Yes	Yes	--	Yes
Capacity	Yes	Yes	No	Yes	--	Yes
Coverage	Yes	Yes	Yes	Yes	--	Maybe
Price	Yes	Yes	No	Likely	--	Likely
Quality	Yes	Yes	Yes	Yes	--	Yes
Personal Number	Not Really	Yes	No	Yes	--	Yes
Intelligent Features	Some	Many	Some	Many	--	Many

Source: Technology Futures, Inc.

Exhibit 2
Monthly Prices for Cellular/PCN Telephone Service—*Constant 1992 Dollars*



Source: Technology Futures, Inc.

Exhibit 3
Number of Cellular/PCN Subscribers—*Low-Demand and High-Demand Scenarios*

	Number of Subscribers	
Year	**Low-Demand**	**High-Demand**
1984	0.125	0.13
1985	0.329	0.33
1986	0.655	0.66
1987	1.180	1.18
1988	1.990	1.99
1989	3.500	3.50
1990	5.300	5.30
1991	7.600	7.60
1992	10.17	10.17
1993	13.26	14.11
1994	16.07	19.17
1995	19.02	25.52
1996	23.06	33.40
1997	26.01	43.05
1998	29.34	54.72
1999	33.09	68.71
2000	35.57	85.35
2001	38.24	104.87

Source: Technology Futures, Inc.

Exhibit 4
Wireline Cash Flows—*Low Cellular/PCN Demand Scenario*

Note: All data in 1992 dollars per base access line

Wireline Pct Msg = 50%

1	2	3	4	5	6	7	8	9	10	11	12
	Revenue (Base)			Revenue (Remaining)			Base	Net Income			Net
Year	Msg	Non	Total	Msg	Non	Total	Oper Cost	Before Tax	After Tax	Depr Adj	Cash Flow
1992	327	327	653	327	327	653	478	175	112	120	232
1993	327	327	653	326	326	653	478	175	112	120	231
1994	327	327	653	325	326	652	478	174	111	120	231
1995	327	327	653	324	326	651	478	173	110	120	230
1996	327	327	653	322	326	648	478	170	109	120	228
1997	327	327	653	319	326	645	478	167	107	120	227
1998	327	327	653	316	326	641	478	163	105	120	224
1999	327	327	653	312	325	637	478	159	102	120	221
2000	327	327	653	309	324	633	478	155	99	120	219
2001	327	327	653	305	323	628	478	150	96	120	216
2002	327	327	653	301	322	623	478	145	93	120	212
2003	327	327	653	298	320	618	478	140	89	120	209
2004	327	327	653	293	318	611	478	133	85	120	205
2005	327	327	653	289	316	605	478	127	81	120	201
2006	327	327	653	285	313	598	478	120	77	120	196
2007	327	327	653	280	310	590	478	112	72	120	191
2008	327	327	653	275	307	581	478	103	66	120	186
2009	327	327	653	270	303	573	478	95	61	120	180
2010	327	327	653	264	299	563	478	85	54	120	174
2011	327	327	653	259	294	553	478	75	48	120	168
2012	327	327	653	253	290	543	478	65	41	120	161
2013	327	327	653	247	284	532	478	54	34	120	154
2014	327	327	653	241	279	520	478	42	27	120	146
2015	327	327	653	235	273	508	478	30	19	120	139
2016	327	327	653	229	267	496	478	18	11	120	131
2017	327	327	653	222	261	483	478	5	3	120	122
2018	327	327	653	215	254	469	478	-9	-9	120	111
2019	327	327	653	208	247	455	478	-23	-23	120	96
2020	327	327	653	201	239	440	478	-38	-38	120	82

Source: Technology Futures, Inc.

Exhibit 5
Depreciation Model for the Impact of Cellular/PCN Competition on Wireline Economic Value—*Low Cellular/PCN Demand Scenario and Ignoring Impact of Equipment Retirements*

Scenario
No Retirements

Disc. Rate 10.0%
Base Year 1992

Avg. Remaining Life= 7.70

1	2	3	4	5	6	7
Year	Net Cash Flow	Present Value	Remaining NPV	% of Rem NPV Surviving	% of Eqp. Surviving	Combined % of Value Surviving
1992	232	232	2181	100%	100%	100%
1993	231	210	1949	89%	100%	89%
1994	231	191	1739	80%	100%	80%
1995	230	173	1548	71%	100%	71%
1996	228	156	1376	63%	100%	63%
1997	227	141	1220	56%	100%	56%
1998	224	127	1079	49%	100%	49%
1999	221	114	952	44%	100%	44%
2000	219	102	839	38%	100%	38%
2001	216	91	737	34%	100%	34%
2002	212	82	645	30%	100%	30%
2003	209	73	563	26%	100%	26%
2004	205	65	490	22%	100%	22%
2005	201	58	425	19%	100%	19%
2006	196	52	367	17%	100%	17%
2007	191	46	315	14%	100%	14%
2008	186	40	270	12%	100%	12%
2009	180	36	229	11%	100%	11%
2010	174	31	193	9%	100%	9%
2011	168	27	162	7%	100%	7%
2012	161	24	135	6%	100%	6%
2013	154	21	111	5%	100%	5%
2014	146	18	90	4%	100%	4%
2015	139	15	72	3%	100%	3%
2016	131	13	57	3%	100%	3%
2017	122	11	43	2%	100%	2%
2018	111	9	32	1%	100%	1%
2019	96	7	23	1%	100%	1%
2020	82	6	15	1%	100%	1%

Source: Technology Futures, Inc.

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PERSONAL COMMUNICATIONS (PCS) NUMBERING, A STRATEGIC IMPERATIVE

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1.0 Abstract

This paper will discuss proposed changes in the addressing and routing of calls using various "personal numbers" schemes. It will also analyze the impact of such changes upon near and longer term domestic and international communications architectures and services.

2.0 Introduction

The telecommunications landscape in the Pacific Rim and worldwide will be changed forever as nations implement or otherwise expand numbering systems thereby enhancing the ability of customers to select their service providers based upon choice, and not as a result of telephone numbers tied to geographic locations. These "personal numbers" will be designed to identify customers wherever they may be and allow for incoming and outgoing data and voice communications whether on the landline or on the wireless network. This fundamental shift in addressing and interconnection will have a dramatic effect upon the provision of both domestic and international communications. Several methodologies are being discussed to facilitate such "number portability" worldwide.

Fundamental to such analysis is the consistent application of the following guiding principles:

(1.) independent control of numbering and numbers is an essential element of effective competition;

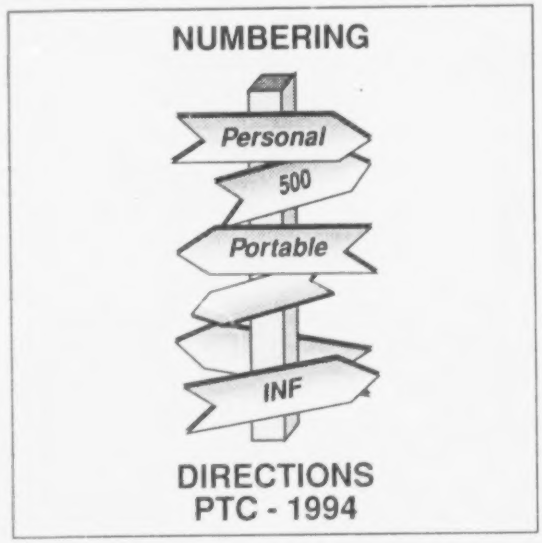
(2.) service providers must have confidence that numbers and codes will be available consistent with increased demand for existing services (e.g., voice telephony) and for new services (e.g., PCS); and

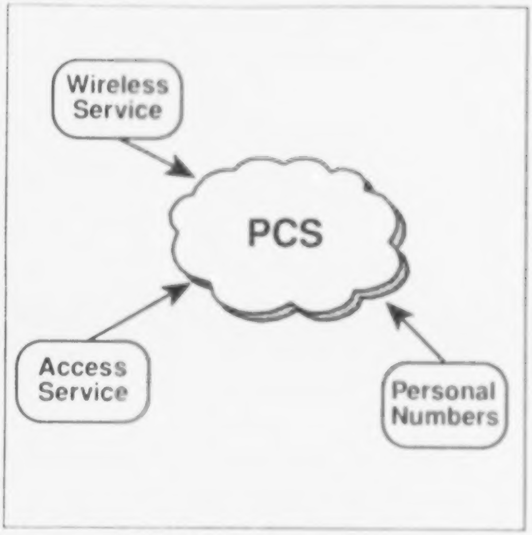
(3.) increasingly, communications will involve interworking between service providers, therefore any good numbering scheme must afford effective and efficient call routing and completion.

Effective management and use of numbering assets may well be as important as the technology selected as networks and services evolve and compete in the global marketplace.

3.0 Personal Communications Services

Personal Communication Services (PCS) can be viewed as a network trilogy - radio architecture/mobile service(s), network access service(s) and/or personal number service(s). It depends upon your point of view. For example, at WARC '92 radio spectrum was allocated worldwide to allow for the provision of "mobile" services throughout the world. In the U.S., the FCC has initiated a process to license previously allocated microwave spectrum to PCS service providers. At ITU/-Telecommunications Standardization (ITU/TS) Sector Study Group 2 a set of standards were developed that also encompasses interconnection between wireline carriers and PCS carriers. Those standards, organized under the designation of UPT (universal public telephone), describe any number of services that could be supplied by traditional wireline carriers to the PCS carriers (without any wireless technology being deployed as part of the landline service). In the U.S., personal numbers have been provided to customers of AT&T's Easyreach™ service using the 700 service access code (SAC, in the form of 700-NXX-XXXX). Also, in the United States, the NANPA is leading the development of a "Long Term Numbering Plan for World Zone 1," that describes a set of non-geographic numbers that can be used, in part, to provide for personal number service.





4.0 Personal ('PCS') Numbers

Telephone numbers have traditionally been used to identify the location of, and the path to, a specific telephone line. That line is therefore a physical location in a specific World Zone, country, and a particular telephone company and switching center. Any traffic that originates from or terminates to that line could be switched using a geographically based numbering and routing scheme. Further, at each step of the call, directionality/routing is determined from the telephone number itself.

As users of today's and emerging communications/information/video services become more sophisticated they will demand more services and the trend to accumulate telephone numbers will become even more prevalent. More and more, customers will require multiple telephone numbers to be used for the home, car, facsimile, business, computer and so on. It will become an issue just to manage the information regarding the assignment of telephone numbers. In Hong Kong, many people have more than one telephone number. The Office of the Telecommunications Authority has recommended that the number series 700 in their numbering plan be reserved for future developments in personal numbering.[1]

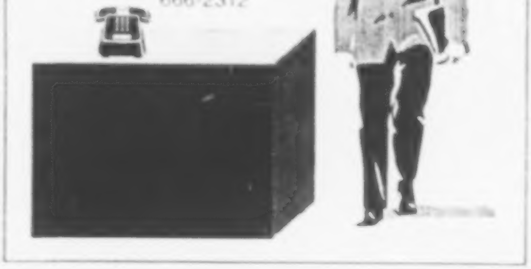
When a person can utilize all of these services, a personal number and profile become sensible. Numbers are a finite resource (at least within the context of a deployed numbering plan) and a personal number that can be applied over various services will conserve that resource and be much less confusing to the end user. If the "network" could help better manage the communications events that occur in one's business and personal life by connecting the appropriate device and service based upon the nature of the communication and the customer's instruction, the demand for and adoption of personal numbering plans will accelerate.

In this way the very nature of communications can and will change. It is a strategic imperative for countries and companies to recognize the customer impact of personal numbers. Personal numbers promise to cause a "sea change" in the communications business. It portends fundamental change in the relationship between service providers and end users.

5.0 E.164, E.168 PCS Numbering Standards

Change is being considered and detailed at the international and domestic level. ITU/Telecommunications Standardization (ITU/TS) Sector Study Group 2 is actively studying the appropriate numbering, addressing and routing plans for PCS. Study Group II defines a personal number as "a dialable number which identifies unambiguously an individual rather that a fixed network position." Study Group II believes that a personal number should have a very simple and basic structure and that this structure must conform to recommendation E.164 which is the "PSTN numbering plan for the ISDN era." Study Group II has developed recommendation E.168, which is based on Recommendation E.164, for PCS numbering. As proposed, its recommendation E.168 contains three schemes for PCS numbering. They are described as follows: home related - where the PCS indicator is contained in the associated customer profile and not in the number; country based - where the PCS indicator is the national destination code; and global (country code based) - where the PCS indicator is allocated as a country code followed by a country identification.

The continued use of country codes is being studied. The need for an integrated plan has been raised that would define the appropriate use of country codes along with the method and criteria for assignment and admin-


PERSONAL NUMBERS
I am leaving for Bangkok, just dial my telephone number
666-2312

istration. This work recommends the elimination of World Zones in order to capture the remaining spare country codes. Perhaps, another geographic boundary may be eliminated - so customer choice can increase.

The Japanese have observed that in the new multi-carrier/enhanced multi-service environment it will be necessary to select both the service provider and individual service within the context of E.164. Other countries feel that for world-wide services the number should not carry any significance because of the need to provide service provider portability.

6.0 International Freephone Service (INF)

International Freephone Service (INF) is envisioned to allow that a customer to be assigned a specific telephone number (of course telephone numbers have little or at least less to do with telephones than with individuals). That INF number would be the same throughout the world and therefore calls destined to that number would be routed to that customer, regardless of its origination and termination. This type of service requires a data base and agreement between national administrations to share data so that universal-INF can be supported worldwide.

The concept of "universal freephone" was accepted at the June 1993 ITU/Telecommunications Standardization (ITU/TS) Sector Study Group 2 meeting with a letter being written to the Telecommunications Standards Bureau requesting that country code 800 be reserved for INF. An ITU/TS Recommendation now needs to be developed to define the service and specify its operation (e.g., assignment guidelines, code administration, and number structure). This process will be completed and approved in the November 1994 time frame. In the United States this particular issue has been accepted by Committee T1 of the Alliance for Telecommunications Industry Solution (formerly the Exchange Carriers Standards Association).

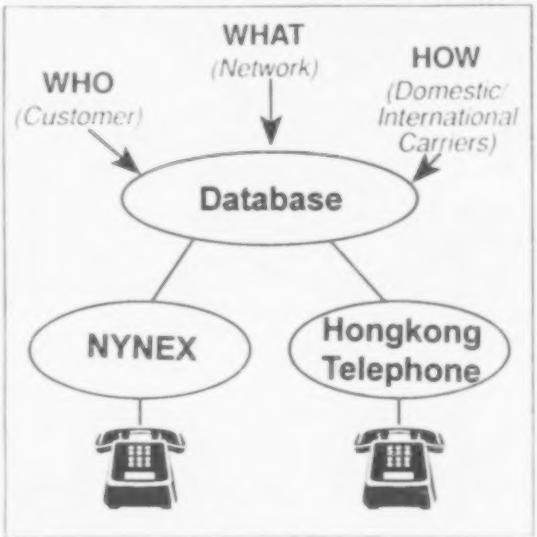
7.0 Regulatory Actions

7.1 Federal Communication Commission (FCC) Announces Investigation of Number Portability[2]

FCC has initiated a proceeding to examine and explore "portability" (i.e., the need and potential for providing customers with the ability to change service providers without changing their telephone number). On August 5, 1993, the FCC asked the industry to consider the proposed assignment of the 500 SAC code in WZ1 for PCS numbering. It sought comments regarding the assignment criteria, its potential exhaust and "methods of achieving 500 number portability, including a proposed schedule, within 30 days" - citing a schedule for Comments and Replies as September 7, 1993 and September 23, 1993 respectively.

Three kinds of number portability are described by the North American Numbering Plan Administrator's "Proposal on the Future of Numbering in WZ1." Location portability affords the end user the ability to keep their telephone number when they move (i.e., their address may change but their telephone number would not change). Another type is defined as providing service provider portability. In this case, the customer of a particular service class (.e.g., PCS) would be able to change service providers. The last type cited is service portability allows a customer to take a number assigned to them by the traditional telephone company to a wireless service provider or vice versa.

The U.S. telecommunication industry responded to the FCC. It described two methods that could be used to provide service using the 500 SAC. The first uses SAC-NXX (C.O. Code) to identify the service provider for specific routing. In this case the call would always be sent to the service provider that is assigned the specific NXX. The second method assigns a SAC-NXX-XXXX to a end user to provide service provider portability. This method requires switch development and the provision of a data base to identify the service provider to route each call. The FCC has yet to decide on the best course of action to provide portability in the U.S.



7.2 Study Group on Telecommunications Numbering - Japan

In Japan, the MPT received a report regarding the telecom numbering plan of 2001. The document was developed by the "Study Group on Telecommunications Numbering." This group, chaired by Dr. Minoru Akiyama, calls for a new numbering plan "so that users can select carriers, networks or services with less digits, using easy-to-remember numbers, enabling new common carriers or existing carriers who wish to provide new services to obtain numbers easily without restrictions imposed by other carriers."[3] This indicates that a move toward a data-based numbering plan is being considered, that at minimum, changes the relationship between geography and service providers. It is then a short step to service provider portability. In the future numbering plan digit 7[00] is reserved for PCS (UPT). Portability is viewed as starting in the local area and then using new data base and intelligent elements expanding beyond the local area.

8.0 The Case for PCS Numbering

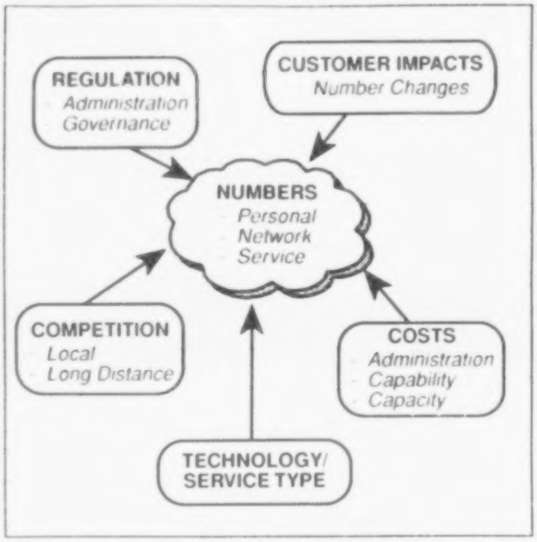
In the "Missing Link," the objective is stated "We believe that by the early part of the next century virtually the whole of mankind should be brought within easy reach of a telephone and, in due course, the other services that telecommunications can provide."[4] Against that backdrop, the strategic imperative for PCS Numbering, begins to clarify.

The future for personal communication as discussed in the preceding requires that customers have the ability to shop for services among competitive service providers without incurring displacement of their personal circle of family or in the case of business their customer base by changing their telephone number (i.e., communications address). The drive to advanced and enhanced telephone/information services will be greatly accelerated if the complexity of numbers is removed from the equation. Government can set the pace for such change by setting the balance between yesterday's and tomorrow's numbering plans.

9.0 The Strategic Imperative

Numbering issues that are being addressed because of PCS include personal numbers and the various types of number portability. Today's numbering systems were conceived and implemented based upon an analogue, a paradigm tied to geography and the difference between networks and nations. These systems are nevertheless, being rebuilt to provide, inexplicable as it may appear, more independence from traditional networks and geography.

Many have said, the transition to portable and personal numbers will be very difficult because of the:
(1.) numbers base - new system must work in both the old and new environment;
(2.) technology infrastructure that needs to be in place is yet to be built, in a widespread way;
(3.) dramatic customer impacts - both in terms of cost and use;
(4.) network impacts - administration, capability, capacity; and
(5.) needed internetworking arrangements are not in place.



Yet at many levels, as discussed in this paper, network operators, standards bodies and regulators are advancing toward portable and personal numbers. In some case it is service driven (e.g., International Freephone Service). In others it is technology driven. Intelligent networks will allow for distributed and different networks to access data base(s) that can facilitate both portability (e.g., 500 Access in the U.S.) and personal numbers worldwide. Regulators in Japan and Hong Kong are selecting new areas of their numbering plans to begin the provision of portable and personal numbers. In the U.S., the FCC is looking to industry to identify a transition plan for providing 500 Access number portability[5].

The next push to portable/personal numbers may be the licensing of PCS radio operators in the U.S. These companies will need to compete with both the cellular and local telephone company for the "existing" end user customer base and, at the same time, local and long distance telephone companies will be seeking to provide PSTN access to the PCS carriers. It will be no surprise that portable/personal numbering will be at the heart of these activities.

1.A Draft Numbering Plan For Telecommunications Services In Hong Kong, Issued by the Office of the Telecommunications Authority, 1993

2.Public Notice, Federal Communication Commission, August 5, 1993, "Commission Requests Comment on Proposed Assignment of the 500 Service Access Code for Personal Communications Services"

3.New Breeze, Quarterly of the ITU Association of Japan, Inc., Vol.5 No.2 Summer, July 1993, ISSN 0915-3160, p. 25

4.The Missing Link, 1984 Report of the Independent Commission for Worldwide Telecommunications Development, p.4, Executive Summary

5.ATIS, ICCF, Number Portability Workshop Mission, "The Number Portability Workshop will develop a consensus definition of number portability, describe the possible network architectures and/or provisioning alternatives which could support it and assess the technical feasibility and implementation requirements with each." (Draft - 9/15/93)

Assessing the Scope of Global Personal Communication Services

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ABSTRACT

Technological innovations in mobile communications present the near term prospect for service any time, any place via handheld terminals. The unprecedented marketplace success of cellular radio and other mobile technologies confirm our desire to stay in touch while on the move. Low and middle earth orbiting satellite projects, like Iridium, Globalstar and Project 21 will augment terrestrial options and make personal communications global in scope. This paper will introduce the concept of Global Personal Communication Services ("Global PCS"). It will identify the numerous marketplace, regulatory and logistical issues that challenge this vision with an eye toward assessing whether and how Global PCS will integrate with existing services provided by incumbent carriers. The paper also will consider which constituencies will embrace Global PCS and which will consider it a by-pass threat.

Mobile communications constitute one of the key developing markets both for incumbent carriers and newcomers. In the United States, cellular radio has grown from virtually no subscribers in 1983 to over 10 million subscribers, at the end of 1992. [1] Even with this kind of growth, cellular radio has achieved a penetration rate of only about 4 subscribers per one hundred inhabitants versus approximately 54.5 terrestrial telephone lines per one hundred inhabitants. [2] It has much upside growth potential before market saturation, even in the most developed nations.

Internationally, cellular radio and other mobile technologies have achieved similarly impressive growth rates. [3] Predictions that "the distinction between fixed versus mobile communications will disappear in the mid-1990s," [4] identify the goal set by proponents for widespread deployment of mobile telecommunication technologies for both upmarket business applications and basic telecommunication capability in areas not served, or underserved by conventional wireline facilities.

The unprecedented marketplace success of cellular radio and the prospects for personal communication networks confirm our desire to stay in touch while on the move. But for the time being, demand levels support only terrestrial "islands" of local service via cellular and special mobile radio, with international service provided primarily by Inmarsat [5] to "luggable" terminals at approximately $10 a minute. In addition to the question whether the marketplace will support more widespread deployment of mobile services, complex spectrum allocation issues need resolution so that both terrestrial and satellite services will have ample, usable spectrum available.

Consumers desire ubiquitous telecommunication primarily because wireless technologies can increase productivity and customer service. Over the next decade, mobile telecommunication services will provide end-to-end services, with increasing volumes routed outside the incumbent wireline carrier's Public Switched Telephone Network ("PSTN").

Future developments include satellite-delivered services, available anytime and anywhere. Should these services evolve along with the anticipated build out of terrestrial options, a major paradigm shift [6] may occur: the conversion of mobile services from constituting minor adjuncts to incumbent, primarily wireline carrier networks, to constituting competitive service providers with ample, discrete traffic.

The Old Service Paradigm in Mobile Communications

Heretofore, incumbent carriers provided mobile radio as a minor adjunct to wireline services. Mobile radio did not constitute a stand alone network, because the vast majority of traffic either originated or terminated on wireline facilities.[7] While lucrative, mobile radio was considered a secondary vehicle for stimulating additional traffic for carriage over existing facilities, and for making the wireline network accessible to mobile users.

Consumers of such services appreciated the convenience of not having to stop and locate a pay phone. They did not think in terms of bypassing the conventional telephone network, or using mobile facilities to avoid long distance toll charges. Mobile radio fundamentally was a local service limited by the range of transmitters operating on few channels, without broad geographical coverage and lacking the capability to route traffic among transmitters and between networks.

A New Service Definition

Regulators primarily have considered personal and wireless communications as closed, self-contained services. Under this conceptualization, mobile services do not generate concerns about the financial impact on the conventional wireline infrastructure. But, depending on one's view of future prospects, mobile services have the potential to extend and augment further the services of incumbent carriers, or to pose a financial and facilities by-pass threat.

Perhaps a better way to consider mobile services is to think in terms of inter-personal, ubiquitous communications provided via tetherless technologies typically linked with existing wireline networks.

1) inter-personal, because the primary purpose of such services is to expand accessibility and scope of options available to mobile users;

2) ubiquitous, because interconnected terrestrial networks and satellite systems can provide worldwide coverage, and thereby realize the full potential for Global personal communication services ("Global PCS");

3) tetherless, because Global PCS serves users' interests in freedom from cords regardless of whether the network is independent from the existing wireline infrastructure; and

4) linked with existing wireline networks in a partnership to expand the reach and utility of both networks, rather than serving as a minor adjunct to incumbent wireline facilities.

The New Service Paradigm in Mobile Communications

Decisions by developed and developing nations alike to authorize competition in cellular radio evidences the willingness to stimulate development of multiple carrier networks. In deviating from a single, primarily wireline system, nations have endorsed the view that mobile services will generate ample traffic volumes and that incumbent carriers are not entitled to capture all of these markets and deem them an extension of monopoly services.

Endorsing market entry does present new risks and challenges. Legislators and regulators do not intend on creating a vehicle for new carriers to avoid paying the full cost of switching and routing services provided by the incumbent wireline carrier. Technological innovations and the incumbent's pricing policies create the potential for aggregating traffic requiring interconnection in such a way as to make it difficult for the wireline carrier to:

- identify the origin of the call;
- impose an accounting rate settlement; [8] and
- treat such traffic as generated by a customer, as opposed to another carrier.

Currently, carriers tasked with terminating traffic into the PSTN typically have no knowledge of where a call originated. While automatic number identification and out of band signaling technology may proliferate in the future, it remains uncertain whether wireline carriers can demand the availability of such information as a precondition to carriage, particularly where they might not be able to coordinate the transmission of such data across borders and networks.

Without such information, incumbent carriers may receive foreign country originated traffic, but treat it as local. When this occurs, the terminating carrier misses an accounting rate settlement, or at least some degree of financial compensation beyond what it would charge for conventional, often non-metered, local exchange service. Worst of all perhaps, the wireline carrier has no reliable means to calculate the volume of such traffic that should have generated significantly more revenue.

The policy liberalization trend, [9] which supports market entry by new categories of carriers, similarly promotes more widespread leakage of toll traffic into the PSTN as if it were a local call. The availability of new value added networks, basic voice resale, one-stop shopping services by carriers and non-carrier outsourcers, and new traffic hubbing arrangements means that enterprises will the telecommunications marketplace without any public utility orientation or broad public service commitment.

These new types of operators have achieved legitimacy with the regulatory agency or Ministry that grants authority to operate. Contrary to their incumbent carrier counterparts, new ventures may operate as "private" non-common carriers [10] who typically consider telecommunications a competitive undertaking where minutes of network use are fungible. New operators must find operational or financial advantages, lest customers migrate to other options, including the mobile services of incumbents. It matters very little to new mobile service providers that leakage into the PSTN may violate some policy [11] or tariff. If the wireline carrier providing the carriage cannot or will not monitor the traffic flow, then the new carrier surely will not refrain from taking advantage of the situation.

Customer Sovereignty

Both incumbent and new carriers now recognize growing consumer clout and increasing unwillingness to accept unilateral service terms and conditions. While carriers still match half-circuits, they see real financial advantages in achieving market share in other markets previously considered off limits to domestic or foreign competitors. Incumbent carriers have sought mobile licenses in foreign countries and have devised new software-defined "virtual" service arrangements to retain customers no longer "captive" to offerings of an indigenous monopoly carrier.

As never before, carriers must vie for high volume customers, particularly ones with multinational traffic streams. Very much like airlines, telecommunication carriers have to devise innovative ways to confer discounts to frequent travelers on their networks to retain loyalty, particularly where carriers can capture traffic volumes by erecting a hub, e.g., a satellite gateway or switch connected to wireline facilities, for routing traffic throughout a region.

This newfound pragmatism encourages aggressiveness to the point of "poaching" the customers of other carriers. So far, the incentive to generate greater traffic volumes has only resulted in selective price cutting. The prevailing tactic now is to evidence such greater customer service, network functionality and general flexibility that customers will design or reroute network to transit the innovative carrier's regional hub. Private networks increasingly serve specialized customer requirements, making functionality the key factor with geography, different numbering plans and political boundaries increasingly avoidable impediments. Sophisticated users design "nomadic" intracorporate networks using the facilities of several carriers to ensure redundancy. The expertise necessary to establish such private networks also helps users to exploit technological anomalies that enable traffic routing exempt from otherwise applicable accounting rate settlements.

Telecommunication carriers have to demonstrate greater flexibility to accommodate customer requirements, because the twin impact of technological innovation and policy liberalization all but mandates it. If somewhere within a region, mobile service providers, resellers of leased lines and users have opportunities to exploit such innovations, then over time, incumbents can expect to lose traffic and revenues when they cannot, or refuse to innovate.

The leakiness of Private Branch Exchanges, cross-border mobile radio services, the permeability of regional private line networks, transborder satellite footprints, resale of leased lines, accounting rate evasion and a host of other factors result in tipping the balance decidedly in favor of the customer. The prudent incumbent carrier heeds the call for more robust mobile services, one-stop shopping, heightened responsiveness to user requirements, and upgraded networks. A satisfied customer is less likely to exercise the freedom to lease or buy terminal equipment from new vendors, or to relocate all or some operations to take advantage of upgraded networks elsewhere.

Conventional, micro- and pico-cellular radio at the local and regional levels and satellite services at the global level may evolve to a point of near parity in terms of traffic volumes. Even before that point, operators will develop their own settlements process to route long haul traffic, by daisy chain interconnection of local facilities, or by a new type of settlements arrangement between unaffiliated operators. Incumbent wireline carriers must accommodate user demand for more extensive and flexible mobile services. In the process of satisfying new consumer imperatives the carrier must establish more equitable arrangements for interconnecting facilities and dividing toll revenues.

Satellite-Delivered Mobile Telecommunications

Low and middle earth orbiting satellite projects, like Motorola's Iridium, TRW's Odyssey, and Loral/Qualcomm's Globalstar will make mobile satellite service ("MSS") global in scope. These ventures include a constellation of between 12 and 66 non-geostationary orbiting ("GSO") satellites [12] providing an inter-operating array of beams that illuminate the entire globe. Individually and collectively these systems aim to provide ubiquitous, [13] wireless, digital coverage to pocket-sized telephones.

The concept of Global PCS requires a satellite-delivered component to provide users with ubiquitous and flexible communication options free of cords. However, numerous marketplace and regulatory issues challenge this vision.

Marketplace Challenges to the Old Service Paradigm

Satellite delivered Global PSC can provide a stand alone international service network, independent of existing Fixed Satellite Services. While the proponents of LEO and GSO satellites would gladly welcome participation by incumbents, it may be that such services present too much risk in terms of disruption to the status quo. Furthermore, the International Maritime Satellite Organization ("Inmarsat") has proposed a system for use by its incumbent carrier constituency to provide MSS to small terminals.

Inmarsat's Project 21 might preempt the prospects for private ventures, thereby enabling the incumbents to manage the timely deployment of a new technology, rather than have it introduced by new carriers with no interest in mitigating the potential adverse financial impact on incumbents.

Regulatory Challenges

A number of regulatory issues also must be resolved, including spectrum allocation, standard setting, numbering plans and license classification. Because the International Telecommunication Union has allocated all usable spectrum in service-specific blocks, newcomers will require a reallocation, particularly if the proposed service cannot fit within existing categories and cannot easily share with incumbent operators. This process presents incumbents, as longstanding and dominant participants in the ITU, with a possible vehicle to block or condition spectrum allocation needed by newcomers.

Coalitions of incumbent carriers, must notably the Conference of European Post and Telecommunication Administrations ("CEPT") attempted to block a spectrum allocation for MSS usable by LEO satellites [14] at the 1992 World Administrative Radio Conference ("WARC-92") held in Malaga-Torremolinos, Spain. Such opposition resulted in part from the desire to favor terrestrial mobile radio options, and perhaps also to blunt the apparent marketplace headstart accruing to primarily non-European ventures.

Incumbents did succeed in blocking a United States initiative to allocate a large block of spectrum for generic satellite service, rather than the customary allocation on a service specific basis, e.g., land mobile, or maritime, or aeronautical satellite services. They also imposed a burdensome coordination process that will limit the likelihood that operators of specific terrestrial or GSO satellite services would have to share spectrum, or to relocate to another frequency band.[15]

Private Carriage

To achieve the vision of ubiquitous Global PCS, regulators should create an environment supporting investment in new non-wireline networks. A private carrier designation in the United States means that tetherless communication operators can provide service on contractual terms and conditions without conventional regulation. Such a designation affords greater flexibility in configuring service, and fosters competition by creating an environment conducive to market entry and growth. It also would make it possible for foreigners to make sizeable investments as alien ownership restrictions in the United States are less burdensome for non-common carriers.

On the other hand, the private carrier designation may further brand newcomers as opportunists and creamskimmers. The category by definition frees operators from universal service obligations, and the assumption that what they offer is essential, as opposed to supplemental service. Governments, perhaps at the behest of incumbent carriers, may curb the permissible scope of mobile service opportunities available to new carriers.

Conclusion

Numerous marketplace and regulatory issues challenge visions of ubiquitous, tetherless communications. Incumbent carriers are leery of making substantial investments in technologies that may rival, rather than support existing facilities. However, if they refrain from making such investments, and newcomers are allowed to operate, the new carrier paradigm will be strengthened and may evolve to a point where its operators will capture increasingly significant market share resulting from user migration off wireline and fixed service satellites. Should such new carriers develop stand alone networks with lucrative traffic volumes, they may become strong rivals to incumbents without much of the regulatory burdens that reduce revenues and flexibility.

On regulatory and spectrum management issues, WARC-92 provided clear evidence of how far nations can go to resolve disagreements and different visions when they seek solutions and are willing to compromise positions. However, individual nations have a regulatory and licensing process that favors procedural fairness, perhaps at the expense of timeliness and efficiency. National regulatory agencies, including the FCC, should follow the model of success reached at WARC-92 and expedite the deployment of desirable technologies and services, despite the potential challenge to the status quo.

1. Lenz, "U.S. Telephony in 2000: Cutting the Ties That Bind," 1 New Telecom Quarterly No. 1, 10, 11 (1993).

2. G. Staple, ed. TeleGeography 1992 p. 61 (Washington, D.C.: International Inst. of Communications, 1992); see also, Dept. of Commerce, National Telecommunications and Information Administration, The NTIA Infrastructure Report: Telecommunications in the Age of Information, 171 (Washington, D.C.: Gov. Printing Off., 1991) (reporting 49 lines per 100 population in 1990).

3. See Id. at 173.

4. D. Connaughton, "The 1990s May Be the Wireless Decade," 17 Telocator No. 6, pp. 16, 18 (June, 1993).

5. The International Maritime Satellite Organization ("INMARSAT") is a global cooperative, formed by intergovernmental agreement, to provide ubiquitous maritime telecommunications to ships in the high seas, with aeronautical and land mobile services available on an ancillary basis. See Convention of the International Maritime Satellite Organization, opened for signature, July 16, 1979, 31 U.S.T. 1, T.I.A.S. No. 9605.

6. In TeleGeography 1992, Gregory C. Staple explored the prospects for a new brand of "light carrier" to migrate traffic and revenues from incumbent "heavy carriers." The former primarily lease capacity over which traffic is rerouted, repackaged or reprogrammed at significantly lower rates, often made possible by avoiding application of above cost international accounting rates. See Gregory C. Staple, "Winning The Global Telecoms Market: The Old Service Paradigm And The Next One," in Gregory C. Staple, ed., TeleGeography 1992, 32-53 (Washington, D.C.:International Institute of Communications, 1992).

7. "For almost a century the key institutional feature of traditional telephony around the world has been a ubiquitous network operated by a monopolist. . . . Public telecommunications were not merely a technical system, but social, political and economic institutions. . . . The PTTs were supported by a broad political coalition, a 'postal-industrial complex.' It included the PTT itself and the equipment industry as its supplier, together with residential and rural users, trade unions, the political left, the newspaper industry (whose postal and telegraph rates were heavily subsidized), and affiliated experts. The system worked in no small measure to the benefit of the [domestic] equipment industry." E. Noam, "International Telecommunications in Transition," in R. Crandall and K. Flamm eds., Changing the Rules: Technological Change, International Competition and Regulation in Communications, 257, 258 (Washington: The Brookings Institution, 1989).

8. The United States has incurred a significant deficit in the division of toll revenues for international switched telephone service. The Federal Communications Commission began to consider the

problem seriously when it reported that the United States had incurred a nearly $2 billion deficit in 1988. See Regulation of International Accounting Rates, CC Docket No. 90-337, Phase I, Report and Order, 6 FCC Rcd. 3552 (1991). The deficit now exceeds $3 billion. Regulation of International Accounting Rates, CC Docket No. 90-337, Phase II, 6 FCC Rcd. 3434, 3436 (1991).

The Commission estimates that half of the United States deficit results from significantly higher outbound United States calling volumes, the product of a larger population than the foreign nation and the stimulative effect of much lower call charges. The other half occurs, because the "accounting rate" negotiated by international carriers to reflect the cost of a complete international call far exceeds actual costs and greatly raises the level of payouts United States carriers must make to settle accounts with foreign carriers.

For an extensive background on accounting rates, see Frieden, "International Toll Revenue Division: Tackling the Inequities and Inefficiencies," 17 Telecommunications Policy No. 3 (April, 1993) L. Johnson, "Dealing With Monopoly In International Telephone Service: A U.S. Perspective," 4 Information Economics and Policy 225-247 (1989/91); K. Cheong and M. Mullins, "International telephone service imbalances Accounting rates and regulatory policy, 15 Telecommunications Policy No. 3, 107-118 (April, 1991); and K. Stanley, "Balance of Payments Deficits, and Subsidies in International Communications Services: A New Challenge to Regulation, 43 Administrative Law Review 411-438 (Summer, 1991); R. Frieden, "Accounting Rates: The Business of International Telecommunications and the Incentive to Cheat," 43 Federal Communications Law Journal 111-139 (April, 1991).

9. It is important to understand the differences in the scope and impact of these major trends. Privatization only involves the change in legal status of the PTT from public to private ownership. The new company may enjoy a private (as opposed to public) monopoly, the government may hold stock ownership in the new company, and all preexisting regulations may remain in force. Typically, but not always, privatization is coupled with deregulation: government permits a degree of competition, streamlines regulatory requirements and reduces oversight to allow the privatized carrier flexibility to respond to changing conditions. Liberalization also may occur around the time the PTT is privatized. It involves the selective reduction of structural safeguards and burdens imposed on the PTT, e.g., ordering the PTT to provide cost-based network access to competitors or users, and permitting users to own telephones and other devices that directly interconnect with PTT networks. It may also free the PTT of social obligations to provide certain services at non-compensatory rates.

10. See National Association of Regulatory Utility Commissioners v. FCC, 525 F.2d 630 (D.C. Cir. 1976), cert. den. sub nom. National Association of Radiotelephone Systems v. FCC, 425 U.S. 992 (1976) (affirming FCC decision to categorize special mobile radio service as non-common carriage).

11. Only in rare instances has the FCC imposed safeguards to preclude access to the PSTN. In the case of private fixed service satellites, separate from the INTELSAT cooperative, the FCC imposed an Executive Branch policy designed to insulate INTELSAT from switched service competition. The "Separate System" policy initially prohibited PSTN access, required long term contractual relations and favorable conclusion of mandatory consultation with INTELSAT to avoid causing technical or economic harm. The FCC subsequently modified the policy to permit up to 1250 (64 kilobits per second) bearer circuits of switched traffic, and plans to eliminate restrictions on switched services in 1997. See Ronald Reagan, Presidential Determination No. 85-2, 49 Fed. Reg. 46,987 (Nov. 28, 1984), implemented in Establishment of Satellite Systems Providing International Communications, 101 FCC 2d 1046 (1985), on recon., 61 Rad. Reg. 2d (P&F) 649 (1986), on further recon., 1 FCC Rcd, 439 (1986) policy liberalized in, Permissible Scope of United States Licensed International Communications Satellite Systems Separate from the International Telecommunications Satellite Organization (INTELSAT), 7 FCC Rcd. 2313 (1992).

12. "A geostationary satellite's circular and direct orbit lies in the plane of the Earth's equator and remains fixed relative to the Earth. The distance to the Earth is approximately 35,785 km (22,235 miles)." Amendment of Sec. 2.106 of the Commission's Rules to Allocate Spectrum to the Fixed-Satellite Service and the Mobile-Satellite Service for Low-Earth Orbit Satellites, Notice of Proposed Rulemaking, ET Docket No. 91-280, 6 FCC Rcd. 5932, n. 2 (1991). "LEO satellites are satellites that are not in geostationary orbit about the earth. LEO satellites orbit the earth at altitudes generally in the order of 1000 to 2000 km (650-1300 miles). LEO satellites have been utilized primarily for military, scientific, and amateur radio communications purposes." id., 6 FCC Rcd. at 5932.

13. "We believe that the demand for mobile-satellite service [MSS] is beginning to grow. Until recently, most MSS has been limited to maritime systems, but recent years have seen a significant increase in interest in providing land and aeronautical MSS." An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum, GEN Docket No. 89-554, Second Notice of Inquiry, 5 FCC Rcd. 6046, 6055 (1990).

14. The extensive efforts by CEPT to block mobile satellite spectrum allocations prompted Ambassador Jan Baran, the United States Delegation Head to WARC-92, to allege that "an organized bloc of 32 European countries . . .often appeared to oppose new technologies." "U.S. 'Big LEOs Get Allocations At WARC Largely As Proposed, But Limits Aimed At Protecting Russian Glonass System Could Restrict IRIDIUM; CEPT Nations Get 230 MHz For Future Public Land Mobile Service; BSS-Sound Gains Worldwide Allocation At L-Band," 59 Telecommunications Reports, No. 9 at p. 12 (March 9, 1992).

The State Department's unclassified wrap-up cable declared success, in "buck[ing] the inertia and caution of the radio community, suspicion and stonewalling by a well-organized European block of thirty-two countries, and Russian single mindedness in protecting its GLONASS radionavigation satellite system." Ambassador Jan Baran, "U.S. Success at World Administrative Radio Conference (WARC'92): Wrap-up Cable (March 3, 1992).

15. See International Telecommunication Union, Addendum and Corrigendum to the Final Acts of the World Administrative Radio Conference (WARC-92), Malaga-Torremolinos, (1992); Resolution Com5/8, Interim Procedures for the Coordination and Notification of Frequency Assignments of Non-Geostationary-Satellite Networks in Certain Space Services and the Other Services to Which the Bands are Allocated, in Final Acts of the World Administrative Conference (WARC-92), Malaga-Torremolinos, 1992 at 101-113.

UNITED STATES PCS POLICY AND RURAL DEVELOPMENT

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1. ABSTRACT

This paper updates an earlier report on Personal Communication Services (PCS) for rural areas of the United States. It reviews FCC PCS policy on five topics important to rural areas: spectrum allocation, licensing procedures, service area definition, eligible license applicants, and standards setting.

2. INTRODUCTION

In summer 1992 the FCC noted that

> The advent of PCS will have a great impact on the future development and configuration of all telecommunications networks by improving significantly their flexibility and functionality. Many PCS applications should create new markets and in others provide competition for the first time. PCS also could provide a greater overall level of competition in many already competitive segments of the telecommunications industry. The many applications of PCS also could increase productivity and efficiency across a broad array of industries and have a positive impact on the international competitiveness of the Nation's economy.[1]

The FCC's prediction may well come true in respect to the national economy. However, what benefits the national economy does not necessarily benefit all the nation's people. Arguably, people who drive long distances and live and work in isolated areas may need PCS more than most others. Yet, if distribution of cellular services is any indication of what we might expect in PCS availability, only rural residents who reside by major highways or close to metropolitan areas will enjoy the benefits of the "wireless revolution."

This paper updates a 1993 NASA-funded study by Robinson, Abramson, Parker and Povey for Jet Propulsion Laboratory (JPL).[2] That study presents evidence that rural residents both need and want advanced mobile communication services In the interests of space, we will not repeat that discussion here. Instead we will review the current status of five PCS issues important to rural areas: spectrum allocation, licensing procedures, eligible license applicants, service area definitions, and standards setting.

3. SPECTRUM ALLOCATION

3.1 TWO APPROACHES

Because the U.S. is a such a heavy user of spectrum space, the FCC has been struggling with how to allocate frequencies for new wireless services. One approach has been to free up blocks of space by relocating present users to alternative frequencies and to other transmission technologies. A second approach is to convert some of the Federal Government's spectrum space to public or shared government-public uses.

3.2 REALLOCATION OF PUBLIC SPECTRUM

In December 1991 the FCC Office of Engineering and Technology articulated four evaluation criteria for selection of new technologies bands: availability of reasonably priced equipment; availability of sufficient amounts of neighboring spectrum space for cell connections; possible relocation of current users without substantial harm to their operations; compatibility with existing and expected WARC allocations. The Commission divided "new technologies" allocations into four categories: general new technologies, narrowband PCS, unlicensed PCS and licensed PCS.

The Commission issued its final rulings on redevelopment of spectrum to encourage innovation in the use of new telecommunications technologies in September 1993.[3] These decisions completed the Commission's relocation of fixed microwave operations so emerging technologies can use the reallocated 2 GHz bands. By "emerging technologies" the FCC refers specifically to wireless communications services, although PCS is only one family of services within that general designation.

In August 1993 the FCC allocated frequencies for narrowband PCS, adopted technical and operational rules, and decided to grant one out of 19 pioneer's preference requests. The Commission deferred action on licensee selection procedures and regulatory status.[4] In this ruling PCS is defined as "radio services that encompass a wide array of mobile and ancillary fixed communications services that could provide services to individuals and businesses, and be integrated with a variety of competing networks." PCS is specifically not broadcasting and any associated fixed services must be needed to support mobile communications.

"Narrowband" PCS is defined as PCS using the allocated 900 MHz bands. The FCC explicitly has not confined narrowband applications to advanced paging and messaging in the expectation that other services may be proposed.

In late September 1993 the Commission issued its *Second Report and Order* in the rule making process begun on September 4, 1992.[5] In this latest ruling the FCC allocated spectrum, adopted licensing and authorization rules, and formulated technical standards for 2 GHz licensed and unlicensed general PCS. The Commission defined general PCS as "a variety of new mobile services, technologies, and equipment such as small, lightweight telephone handsets; portable facsimile machines; wireless PBXs' and multi-channel digital cordless telephones", conspicuously omitting wireless computers and personal digital assistants from the example list. This rule making applies to both licensed and unlicensed PCS.

The Commission's vision of PCS is important to rural areas for it may well be that wireless services will substitute for fixed services of all types, including video, in some regions. AT&T and other industry visionaries have envisioned that even full motion video will be provided by third generation wireless technology. A limited FCC vision could constrain development of such a broad array of wireless services for rural areas.

FCC PCS allocations are summarized in Table 1.

The FCC has allocated a total of 220 MHz for emerging technologies. It originally planned on using only 110 MHz for PCS but ended up allocating 160 MHz for this new family of services. That move left 60 MHz for other new technologies applications. The non-PCS new technologies allocations remaining are the 1970-1990/ 2110-2130/ 2160-2180 MHz bands.

One possible use of the remaining new technologies bands is satellite distribution of PCS services. It is important to note that the PCS allocations made apply only to terrestrial delivery systems. In rural areas satellite delivery systems will be economically and technically more efficient.[14] Rapid implementation of satellite delivery of PCS is important for realization of rural mobile services but the FCC has not moved as quickly on formulation of satellite policy as it has on its terrestrial regulatory framework.

The Commission has allocated frequencies to "little LEO" systems. Little LEOS (Low Earth Orbit Satellites) will operate below 1 GHz and "big LEOs" above 1 GHz. Middle-Earth Orbit (MEO) systems presumably will use big LEO allocations. Big LEO allocations were expected to be finalized in December 1993 or January 1994 after the writing of this paper.

Big LEO applicants such as Ellipsat, Loral/Qualcomm, Constellation and Motorola as well as TRW (a MEO system) have been urging the FCC to move more quickly on setting up the regulatory framework for satellite delivery of PCS despite some still unresolved issues at the international level. Chairman Quello asserts that "it is unnecessary and imprudent to await global action on LEO mobile satellite issues."[15] The Commission has allocated frequencies for GEO (Geosynchronous) systems.

Proposed and allocated mobile communication satellite frequencies are summarized in Table 2.

3.3 CONVERSION OF GOVERNMENT SPECTRUM

In August 1993, as part of the *Omnibus Budget Reconciliation Act*, Congress directed the National Telecommunications and Information Administration and the FCC "to conduct joint spectrum planning with respect to": "future spectrum requirements for public and private uses"; "spectrum allocation actions necessary to accommodate those uses"; and "actions necessary to promote the efficient use of the spectrum, including . . . shared use . . . as a means of increasing commercial access."[24]

Congress stipulated that a minimum of 200 MHz of Federal Government spectrum be reallocated for non-Federal use. All of these are to be made available within 15 years, some within ten and at least 50 MHz within 6

Table 1: FCC Allocated PCS-Related Spectrum Space[6]

Service	FCC proposed and allocated spectrum space
1.narrowband PCS applications[7] (no delivery restriction)	901-902, 930-931 (unpaired), 940-41 MHz allocated[8] (3 MHz total)
2.unlicensed PCS[9] (terrestrial)	1890-1930 MHz allocated to unlicensed PCS (40 MHz) [10]
3.licensed PCS[11] (no stated delivery restriction but geared toward terrestrial)	1850-1890/1930-1970/2130-2150/2180-2200 MHz allocated to licensed PCS (120 MHz); two 30 MHz blocks, one 20 MHz block, and four 10 MHz blocks, up to seven service providers per service area[12]
4.emerging technologies	1980-1990, 2110-2150, 2160-2200 MHz[13] allocated

Table 2: FCC Proposed and Allocated PCS-Related Satellite Spectrum Space[16]

Service	FCC proposed and allocated spectrum space
1. "Little" LEOs[17]	1. 137-137.025, 137.175-137.825, and 400.15-401 MHz primary allocated 2. 137.025-137.175 and 137.825-138 MHz secondary allocated 3. 148-150.05 and 399.9-400.05 MHz primary allocated
2. "Big" LEOs/MSS[18]	1. 1610-1626.5 and 2483.5-2500 MHz primary, 1613.8 -1626.5 MHz secondary proposed[19] 2. Allocations above 20 GHz for related inter-satellite service[20]
3. MSS (presently GEO)[21]	1. 1545-1558.5, 1646.5-1660.5 MHz (upper L-band) allocated[22] 2. 1525-1530 proposed and 1530-1544, 1626.5-1645.5 MHz (lower L-band) allocated[23] 3. Ka-band (20/30 GHz) use encouraged

months; 25 MHz of the latter must be located below 3 MHz. All reallocated frequencies must be located below 5 GHz and include at least 100 MHz below 3 GHz. Throughout the document Congress emphasized that NTIA and the FCC should encourage "the development and use of new communication technologies." And, as discussed in the following sections, Congress emphasized service to rural areas.

4. ELIGIBLE LICENSE APPLICANTS

The licensed PCS frequency allocation plan provides for up to seven terrestrial providers per service area, a decision that the FCC believes will "facilitate special opportunities to promote the participation in PCS of small businesses; rural telephone companies and businesses owned by minorities and women",[25] a stipulation of Congress in the *Budget Act*. Because the FCC fears unfair competition, cellular operators are restricted to one PCS license of 10 MHz in their cellular service areas. Cellular operators can compete for PCS licenses in areas where their cellular service area reaches less than ten percent of the prospective PCS population or if the cellular operator has less than a 20 percent interest in the PCS area's cellular operations. These restrictions are meaningless for many outlying areas which do not have cellular service.

Opportunity to participate does not assure financial success in the face of the expected level of competition, especially as licensees (except cellular providers) can aggregate up to 40 MHz in one service area and as many service areas as they like. Small rural LECs will find it tough to compete with the rates and comprehensive types of service that regional and national licensees may offer. Also, LECs will not get any set-aside spectrum space because the FCC believes that this would discourage them from developing "their wireline architectures to better accommodate all PCS services" and instead would lead to "architectures optimized solely for use of the set-aside spectrum."[26]

No restrictions are imposed specifically upon cellular and LEC applicants for narrowband PCS licenses. No single licensee can aggregate more than three paired 50 kHz licenses or, in other words, no more than a total of 150 kHz paired with 150 kHz. Because of the myriad combinations of services and choice of channel widths possible, the FCC has not stipulated any specific number of licenses per service area. Narrowband services may be quite different from those currently offered by cellular operators and LECs so rural LECs may be hesitant about entering this market.

The FCC is expected to begin licensing terrestrial PCS in 1994. The Commission has given one GEO satellite applicant, the American Mobile Satellite Consortium (AMSC), the go-ahead for domestic U.S. service but has not licensed any big LEO PCS applicants at this point.

5. LICENSING PROCEDURES

Title VI of the 1993 *Omnibus Budget Reconciliation Act* directs NTIA and the FCC to determine "the extent to which licenses for spectrum use can be issued . . . to increase Federal revenues." In other words, Congress has given the FCC permission to use competitive bidding procedures to choose among mutually exclusive applications for initial licenses or construction permits (Sec. 6002). This procedure can be used only where the licensee will receive compensation from subscribers for enabling them "to receive communications signals" or "to transmit directly communications signals" on the assigned frequencies.

Although Congress left the specific design of the competitive bidding procedures largely to the Commission, the law does outline general procedural guidelines important to rural communication development. Section 6002 states that "the Commission shall include safeguards to protect the public interest . . . and shall seek to promote . . . the following objectives:"

> (A) the development and rapid deployment of new technologies, products, and services for the benefit of the public, *including those residing in rural areas* . . .;
>
> (B) promoting economic opportunity and competition and ensuring that new and innovative technologies are readily accessible to the American people *by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants, including small businesses, rural telephone companies*, and business owned by members of minority groups and women . . . . (emphasis ours)

The Commission is asked to

> (A) consider alternative payment schedules and methods of calculation, including lump sums or guaranteed installment payments . . . ;
>
> (B) include performance requirements such as appropriate deadlines and penalties for performance failures, to ensure prompt delivery of service to rural areas . . . ;
>
> (C) . . . prescribe area designations and bandwidth assignments that promote (i) and equitable distribution of licenses and services among geographic areas, (ii) economic opportunity for a wide variety of applicants, including small businesses, rural telephone companies . . . ;
>
> (D) ensure that small business, rural telephone companies . . . are given the opportunity to participate in the provision of spectrum-based services, and, for such purposes, consider the use of tax certificates, bidding preferences, and other procedures . . . .

Policies such as these hopefully will encourage potential providers to offer terrestrial PCS service in rural areas. Congress permitted the FCC to issue nationwide and regional licenses as well as local, another hopeful sign that at least some licensees will try to cover rural areas.

The Commission is required to complete its PCS licensing rule making process no later than 180 days after enactment of the Budget Act and to implement competitive bidding procedures no later than March 8, 1994. The Commission finalized its PCS spectrum allocations and service area designations in its November 8, 1993 *Final Rule* but it has opened a new rulemaking proceeding for formulation of competitive bidding procedures.[27]

The FCC believes that Congress intended competitive bidding to be used if three criteria are met: 1) mutually exclusive applications have been accepted by the FCC, 2) applications are for construction permits or initial rather than existing licenses, and 3) communication services are to be offered for compensation. The Commission does not intend to use the competitive bidding process for mass media licenses although "wireless cable" and DBS (Direct Broadcast Satellite) license procedures remain ambiguous, an important consideration for future wireless provision of rural video service.[28]

The Commission is required to submit a report to Congress in September 1997 that evaluates whether and to what extent

> (i) competitive bidding significantly improved the efficiency and effectiveness of the process for granting radio spectrum licenses;
>
> (ii) competitive bidding facilitated the introduction of new spectrum-based technologies and the entry of new companies into the telecommunications market;
>
> (iii) *competitive bidding methodologies have secured prompt delivery of service to rural areas and have adequately addressed the needs of rural spectrum users*; and
>
> (iv) small businesses, *rural telephone companies . . . were able to participate successfully in the competitive bidding process;* and
>
> (v) recommending any statutory changes that are needed to improve the competitive bidding process. (emphasis ours)

These requirements will encourage the Commission to further consider rural needs. Retention and modification of the Commission's "pioneer preference" policy may be one way to do this.

In 1992 the Commission set up a two track system for processing PCS applications.[29] A later summary of this "pioneer preference" policy states that

> an applicant that demonstrates that it has developed an innovative proposal that leads to the establishment of a service not currently provided or an enhancement of an existing service will be placed on a pioneer's preference track, and will not be subject to competing applications. Thus, if otherwise qualified, such an applicant will receive a license. Other applicants, including both those that unsuccessfully applied for a preference and those that did not, will compete for the remaining licenses on a separate track.[30]

In October 1993 the FCC said that the competitive bidding scheme created new conditions for PCS license assignment and questioned whether preference rules could or should be used.[31] The Commission thus opened its "pioneer preference" policy to comments.

The problem is that under competitive bidding, where everyone has to pay, can some parties be given a preference? The answer is "perhaps" because the *Omnibus Budget Reconciliation Act*, as we have seen above, does not force the FCC to abandon the public interest in favor of federal revenues. According to Commissioner Andrew Barrett, who dissented from the FCC's decision to call for comments on the status of pioneer's preference, no public policy reason can be found for the Commission no longer encouraging small business and rural company innovation. Barrett argues that these entities continue to need preference if they have to buy spectrum. Furthermore, the FCC granted pioneer preference status even after the point where competitive bidding seemed likely to be realized and to abandon the policy now would be inconsistent.

On the other hand the Commission noted that

> Whereas previously an innovator had no control over obtaining a license, it now may obtain a license by outbidding others. The value of innovation therefore may be considered in the marketplace and measured by the ability to raise the funds necessary to obtain the desired license.[32]

Because potential profit is the most important factor to a commercial company, fewer companies may be willing to invest in development of innovative services and technologies if they do not have the chance of being rewarded for their efforts by preferential treatment. In its October 1993 call for review of the pioneer's preference policy the FCC asked for comments on "limiting acceptance of pioneer requests to applicants that demonstrate their responsibility for innovative technology that results in new service to the public." If the FCC decided to offer discounts on bids to applicants who demonstrated willingness to take on tough public service tasks, for example, providing service to thinly populated areas, rural areas would be served according to the intentions of Congress in the *Omnibus Budget Reconciliation Act*.

The *Budget Act* contains strong directives to the FCC not to forget rural areas and to award licenses "to those persons who make significant contributions to the development of a new telecommunications service or technology." In order to ameliorate the desire to fatten Federal coffers at the expense of various publics' interests, the Commission is specifically warned not to "base a finding of public interest, convenience, and necessity on the expectation of Federal revenues from the use of a system of competitive bidding . . . . " Because Congress demonstrated such concern about PCS service in rural areas, the FCC may well decide that pioneer's preference needs not only to be kept but expanded to include other kinds of public service rather than just technological innovation.

5. SERVICE AREA DEFINITIONS

Alternative service area definitions proposed to the FCC by various parties are summarized in Table 3 along with their advantages and disadvantages for U.S. rural regions.

The FCC has decided to use the Rand McNally Major Trading Areas (MTAs) and Basic Trading Areas (BTAs) as service area definitions. Nationwide licenses also will be issued for narrowband PCS but not for general licensed and unlicensed PCS.

Although 3 MHz has been allocated, the FCC plans to channelize and license only 2 MHz for narrowband PCS at this time. This will include the following: nine 50 kHz channels paired with nine 50 kHz channels; twelve 50 kHz channels paired with twelve 12.5 kHz channels; five 50 kHz unpaired channels; eight 12.5 kHz unpaired channels. The FCC spoke of the need for large narrowband PCS service areas saying that

> Large regional and nationwide licensed service areas provide economies of scale, alleviate some of the problems licensees have experienced when they tried to aggregate smaller licensed service areas, provide for flexibility in the design and implementation of narrowband PCS, and further our goals of fostering the swift implementation and deployment of narrowband PCS systems.

However, in order to encourage broad participation in narrowband PCS no single licensee will be permitted to hold more than 150 kHz paired with 150 kHz.

Although wide area licenses generally are better for outlying areas than smaller ones, the Commission has not emphasized service to rural areas nor is it requiring interoperability or inter-system roaming capability for

Table 3: Proposed PCS Service Area Definitions

Option	Advantages/Disadvantages
Basic Trading Areas (487)[33]	widest participation, fewest economies of scale, metro areas will get service first
Major Trading Areas (47)[34]	restricted participation, greater economies of scale that BTA's, some chance of getting rural coverage from regional providers
Telephone LATAs (194)[35]	wide participation efficient integration of PCS and wire telephone, encouraging to rural LECs
Nationwide	greatest economies of scale, best chance to get rural coverage by single provider, least participation

narrowband PCS. The only pioneer's preference granted went to Mtel for a nationwide license which will offer a variety of two-way services, hopefully to outlying as well as metropolitan areas. Another potentially beneficial decision for rural areas and the small telephone companies that serve many of them is that the FCC placed no restrictions on local exchange carrier (and cellular) licenses. The license period for narrowband PCS is ten years.

Up to seven general PCS licensees per location are possible under the two 30 MHz, one 20 MHz and four 10 MHz block plan.[36] Service areas are defined only by MTAs and BTAs except that the addition of U.S. territories brings the number of areas to 51 and 492 respectively. No national service area has been designated, although the FCC will permit parties to freely aggregate licenses under the new licensing procedure and in the aftermarket, making national service possible.[37] Also, the number of licensees in service areas is likely to be reduced by the stipulation that licensees can aggregate up to 40 MHz in a single area.

FCC Chairman, James Quello, asserts that the FCC's intention is to flexibly accommodate all parties interested in PCS and to let "the market place determine the optimal size of spectrum blocks and service areas."[38] However, Bert Roberts, MCI Chairman, criticizes the FCC's PCS decision for dividing the allocated spectrum into "thousands of licenses, spread across incompatible standards."[39]

The Commission's view on universal wireless service is that

> Licensees must serve with a signal level sufficient to provide adequate service to at least one-third of the population in their license area within five years of being licensed, two-thirds of the population in their licensed area within seven years of being licensed, and 90 percent of the population in their licensed area within ten years of being licensed.[40]

However, it is precisely the ten percent most likely to be left out of this service requirement that may have the greatest need for mobile services.

The 1993 *Omnibus Budget Reconciliation Act* provides a way to circumvent some potential limitations of the FCC's service definitions in respect to rural coverage. The Act enables State public utility commissions to impose requirements on commercial mobile service providers "to ensure the universal availability of telecommunications service at affordable rates" where "such services are a substitute for land line telephone exchange service for a substantial portion of the communications" within their States. The other possibility for universal coverage lies in GEO, MEO and big LEO satellite systems that will offer PCS to the entire nation, and, as much as possible, to the whole world.

6. STANDARDS

Another major obstacle to universal coverage is lack of standardization. The Commission responded in October 1993 to some of Congress' *Omnibus Budget Reconciliation Act* requests with an "Implementation of Sections 3(n) and 332 of the Communications Act; Regulatory Treatment of Mobile Services" *Proposed Rule*.[41] This document asks for comments on definitional problems and explanations of FCC interpretations of definitions.

An example that may affect rural areas is the subsequent definition of "interconnection." The Commission asks whether it "should require commercial mobile service providers to provide interconnection to other mobile service providers" and whether "state regulation of interconnection rates of commercial mobile service providers is preempted." In addition the Commission requests comments on whether "PCS providers of commercial mobile service should be subject to equal access obligations like those imposed on LECs." The answers to these questions will affect the ability of small rural telephone companies and satellite providers of rural PCS to seamlessly interconnect with terrestrial mobile and fixed international networks at reasonable rates.

The FCC's PCS decisions have standardized power and antenna limits. General PCS base stations are limited to 100 watts EIRP and antenna heights up to 300 meters HAAT or up to 2000 HAAT if operating at reduced power. Mobiles are limited to 2 watts EIRP.

One hope for provision of terrestrially- rather than satellite-delivered rural PCS lies in developing base station technology that, according to Nortel Matra, even now can reduce rural investment costs by an estimated 75 percent. Nortel Matra's SmartAntenna system can cover larger areas than most base stations.[42] However, FCC power and antenna limitations for general PCS may prevent innovative terrestrial provision of service to large, sparsely populated, geographic areas.[43]

Narrowband mobile and portable stations are limited to seven watts EIRP. Base stations are limited to 3.5 watts EIRP. Only antennas located 80-200 kilometers from their service area boundaries are limited in height. Base stations closer than 200 kilometers to boundaries are further limited in power. However, power and antenna height waivers will be considered on a case-by-case basis by the FCC and all licensees are permitted to negotiate alternative operating limits with co-channel licensees in adjoining areas. Such flexibility is potentially beneficial to rural licensees who must cover large distances efficiently but who also benefit from the standardization resulting from the normal limits. The Unlicensed PCS Ad Hoc Committee for 2 GHz Microwave Transition and Management (UTAM) will coordinate use of unlicensed PCS devices.

1. *Notice of Proposed Rule Making and Tentative Decision (In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services).* July 16, 1992. GEN Docket No. 90-314, ET Docket No. 92-100.

2. Robinson, Deanna C., Abramson, Norman, Parker, Edwin B. and Povey, David. *The Satellite Local Loop: Space Connections for Universal Access.* Final Report submitted to Jet Propulsion Laboratory. JPL Research and Development Contract No. 959321. June 16, 1993. Research was funded by NASA.

3. *Final Rule* (ET Docket No. 92-9; FCC 93-351), 58 FR 46547, September 2, 1993; *Final Rule* (ET Docket No. 92-9; FCC 93-350), 58 FCC 49220, September 22, 1993.

4. *Final Rule*, GEN Docket No. 90-314 and ET Docket No. 92-100; FCC 93-329), 58 FR 42681, August 11, 1993.

5. See 57 FR 40672.

6. Sources: FCC, NPRM&TD "Amendment of the Commission's Rules to Establish New Personal Communications Services," adopted July 16, 1992; *Communications Daily*, various dates; FCC, PR, "Low-Earth Orbit Satellites Above 1 GHz," adopted August 5, 1992; FCC, O&A, "In the Matter of the Applications of American Mobile Satellite Corporation . . . Communications Satellite Corporation . . . .," adopted January 21, 1992; FCC, O&A, "In the Matter of Applications of Norris Satellite Communications, Inc. . . . . .," adopted June 19, 1992; Tom Mooring and Ray LaForge, FCC, personal interviews, May 7, 14, 17 1993; Rush, October 1992.

7. Proposed for advanced paging, narrowband data, messaging, CT-2 and other such terrestrially-delivered applications.

8. *Final Rule* (GEN Docket No. 90-314 and ET Docket No. 92-100; FCC 93-329), 58 FR 42681, August 11, 1993.

9. Unlicensed services are assigned to a specific band whose frequencies are built into customer devices, for example, garage door openers, cordless phones, PBXs, and so forth. The assigned frequencies are not managed by service providers.

10. *Second Report and Order* (GEN Docket No. 92-314), September 23, 1993. This decision dividing the allocated band between isochronous (mostly voice) and asynchronous (data) services.

11. Licensed providers of PCS service are responsible for management of their assigned spectrum slots. The licensed-unlicensed dichotomy is not as clear as it seems. For example, Southwest Bell wants to offer PBX in buildings (unlicensed) combined with cellular outside (licensed) into a single mobile system.

12. *Notice of Proposed Rule Making and Tentative Decision (In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services)* (GEN Docket No. 90-314, ET Docket No. 92-100), July 16, 1992. On January 16, 1992 the FCC adopted a *Notice of Proposed Rule Making* (ET Docket No. 929), in which it proposed to allocate 220 MHz of spectrum in the 1850-1990, 2110-2150, and 2160-2200 MHz for innovative new services, including PCS. On September 17, 1992 the Commission allocated these bands for new technologies in its *First Report and Order and Third Notice of Proposed Rule Making (In the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies)* (ET Docket No. 92-9, FCC 92-437); see also *Final Rule* (ET Docket No. 92-9; FCC 93-350), 58 FR 49220, September 22, 1993.

13. These allocations subsume PCS allocations within the general framework of "emerging technologies." *First Report and Order and Third Notice of Proposed Rule Making)*, ET Docket No. 92-9, FCC 92-437, September 17, 1992; *Final Rule* (ET Docket No. 92-9; FCC 93-351), 58 FR 46547, September 2, 1993; *Final Rule* (ET docket No. 92-9; FCC 93-350), 58 FR 49220, September 22, 1993.

14. See Robinson, Deanna Campbell, Abramson, Norman, Parker, Edwin B. and Povey, David. *The Satellite Local Loop: Space Connections for Universal Access.* Final Report Submitted to Jet Propulsion Laboratory, JPL Research and Development Contract No. 959321, June 16, 1993. Funded by NASA.

15. *Communications Daily*, Vol. 13, No. 192, Tuesday, October 5, 1993, p. 5.

16. Sources: FCC, NPRM&TD "Amendment of the Commission's Rules to Establish New Personal Communications Services," adopted July 16, 1992; *Communications Daily*, various dates; FCC, PR, "Low-Earth Orbit Satellites Above 1 GHz," adopted August 5, 1992; FCC, O&A, "In the Matter of the Applications of American Mobile Satellite Corporation . . . Communications Satellite Corporation . . . .," adopted January 21, 1992; FCC, O&A, "In the Matter of Applications of Norris Satellite Communications, Inc. . . . . .," adopted June 19, 1992; Tom Mooring and Ray LaForge, FCC, personal interviews, May 7, 14, 17 1993; Rush, October 1992.

17. All these allocations were finalized in the January 14, 1993 *Report and Order (In the Matter of Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum to the Fixed-Satellite Service and the Mobile-Satellite Service for Low-Earth Orbit Satellites)*, ET Docket No. 91-280, FCC 93-29.

18. People are thinking of this space for satellite delivery but terrestrial applications are not excluded explicitly.

19. *Notice of Proposed Rule Making and Tentative Decision (In the Matter of Amendment of Section 2 of the Commission's Rules to Allocate the 1610-1625.5 MHz and the 2483.5-2500 MHz Bands for Use by the Mobile-Satellite Service, Including Non-geostationary Satellites)*, ET Docket No. 92-28, August 5, 1992. This NPRM and TD proposes to allocate general MSS space but seems to apply it primarily to non-geostationary satellite systems (LEOs and MEOs).

20. *Ibid.*

21. The FCC now separates MSS and PCS but the former can be seen as one delivery method for the latter or as part of a hybrid PCS system.

22. July 24, 1986, *Report and Order (Allocation Order)*, 27 MHz to be shared by MSS and the aeronautical mobile satellite service (AMSS) divided as follows: 1545.0-1549.5/1646.5-1651.0 AMSS(R) primary, MSS secondary; 1549.5-1558.5/1651.0-1660.0, shared use with AMSS(R) having priority access over MSS. The 1558.5-1559.0 and 1660.0-1660.5 segments previously allocated to AMSS(R) on a primary basis were left unchanged but with the understanding that they could help in development of MSS.

23. See *Notice of Proposed Rule Making*, February 8, 1990, GEN Docket No. 90-56; *Report and Order and Further Notice of Proposed Rule Making*, May 13, 1993; *Proposed Rule*, June 25, 1993; *Final Rule*, June 30, 1993.

24. *The Omnibus Budged Reconciliation Act*, P.L. 103-66, 107 STAT. 379, Title VI, Sec. 6001.

25. *Final Rule* (GEN Docket No. 90-314; FCC 93-451), 58 FR 5914, November 8, 1993.

26. Ibid.

27. See *Notice of Proposed Rule Making* (PP Docket No. 93-253, Implementation of Section 309(j) of the Communications Act Competitive Bidding), 58 FR 53489, October 15, 1993.

28. See Revisions In PCS Order; FCC Auction Rulemaking to Address Mass Media Exclusions, *Communications Daily*, Vol. 13, No. 186, Monday, September 27, 1993, p. 2.

29. *Memorandum Opinion and Order* (FCC 92-57, released February 26, 1992), 57 FR 7879, March 5, 1992.

30. *Final Rule; petition for further reconsideration* (Establishment of Procedures to Provide a Preference to Applicants Proposing an Allocation for New Services), 58 FR 14328, March 17, 1993.

31. *Proposed Rule* (ET Docket No. 93-266; FCC 93-477), 58 FR 57578, October 26, 1993.

32. *Proposed Rule* (ET Docket No. 93-266; FCC 93-477), 58 FR 57578, October 26, 1993.

33. The 487 "Basic Trading Areas" and the 47 "Major Trading Areas" are defined in the 1992 Rand McNally *Commercial Atlas and Marketing Guide*. For narrowband PCS Alaska is separated from the Seattle MTA and licensed separately. Single MTAs comprise Guam/Northern Mariana Islands, Puerto Rico/US Virgin Islands and American Samoa alone. Each territory is a separately licensed BTA.

34. Populations within the major trading areas range from 1.1 to 26 million.

35. The 194 telephone LATAs (Local Access and Transport Areas) were designated when AT&T's local exchange telephone service was divided among RBOCS (Regional Bell Operating Companies). Long distance service now is competitive but wireline local exchange service is not, although the advent of cellular (and eventually PCS) and potential entrance of cable television firms into point-to-point switched services now threaten the local monopoly. Wireline calls within the LATAs are handled by local exchange carriers, calls between them by interexchange carriers.

36. *Final Rule* (GEN Docket No. 90-314; FCC 93-451), 58 FR 59174, November 8, 1993.

37. Sealed Bids to Predominate; Spectrum Auction Rule Issued by FCC, *Communications Daily*, Thursday, October 14, 1993, p. 7.

38. *Communications Daily*, Vol. 13, No. 192, Tuesday, October 5, 1993, p. 5.

39. White House Set to Announce Support for Lifting MFJ Curbs, *Communications Daily*, Vol. 13, No. 203, Thursday, October 21, 1993, p. 3.

40. *Final Rule* (GEN Docket No. 90-314; FCC 93-451; Amendment of the Commission's Rules to Establish New Personal Communications Services), 58 FR 59174, November 8, 1993.

41. *Proposed Rule* (GN Docket No. 93-252; FCC 93-454), 58 FR 53169, October 14, 1993.

42. Nortel Matra Sends the Right Signals to Mercury One-2-One, *The Financial Times*, October 7, 1993.

43. See Doc. 90-314 for PCS standards. Base stations are limited to 100 w and 300 m antenna height so that coverage of somewhere between 62 and 195 miles.

Radio Access
Towards Telecommunication Service Enhancement
- Personal Handy Phone System

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Abstract

In this paper we report on the latest developments in standardization and the development of the Personal Handy Phone (PHP) system in Japan, and describe the initial trial, which has been underway since October 1993. We will describe the phenomenal growth in Japan and other industrialized nations in cordless and cellular telephone users and in the industry itself. We also discuss how predicted PHP service demand illustrates the high level of user expectation from PHP services exceeding that of existing services. This is followed by an explanation of the PHP system service concept, its effect on the 'outdoor' communications market, format concept and structure, and give an overview of the PHP system. We then discuss the standardization of radio interfaces in the domestic Japanese market, referring to the (already completed) standardization of network interfaces. Next we outline the trial implementation of the PHP system in the city of Sapporo, including the latest details on aims and objectives, service area and monitor numbers. Finally we look at future issues and projected developments in the PHP service industry.

1. Introduction

Remarkable developments in the 20th century in information processing, semi-conductor technologies and communication technologies have increased consumer convenience, especially in urban areas. At the same time, existing services fail to fully satisfy users because of lack of uniform service quality. Television broadcasts are a typical example of this uniformity.

Liberalization of the telecommunication market makes it possible to provide a wide variety of easy-to-use terminals to the public, thus contributing to the development of user-friendly telecommunication terminals. Telecommunication users desire personalized services that they can tailor to their own preferences. This demand is both vast and untapped. The users also want to customize their terminals. Intelligent network functions are indispensable in order to satisfy this strong need for personalization.

It is not clear when the term of "personal communication" was first used. The concept of "personalization" depends on the individual. There is no universally accepted concept for personalization in telecommunication. However, it is true that "radio access" is key word for this concept. The term was first used several years ago with reference to the wireless subscriber line as Dr. Cox proposed in [1]. Wired networks have already started to offer pursuit routing services based on personal ID such as AT&T's "EasyReach 700 Service". However, the concept of "personal communication" is not well supported by the existing services.

The introduction of the Telepoint (CT-2) service in the U.K. and the PCN plan have helped to spread the concept of "personal communication" all over the world [2]. Although the Telepoint service is still not widely introduced throughout the U.K. at this stage, the valuable experience is contributing greatly to the development of other Personal Communications Service and systems. The PCN Service and systems. The PCN plan has been also the founding concept of modern personal communication systems.

In USA, Personal Communications Service is so actively studied and a variety of field tests have been performed.

Demand for mobile and cordless telephones is, like other industrialized nations, high in Japan and the number of users is rising at phenomenal speed.

Figure 1 shows sales figures for analogue cordless telephones. As of the end of 1992, a total of nearly 15 million units had been sold, some 27% of all telephone terminals across the nation. This figure indicates that Japan has one of the most largest market of cordless telephones over the world.

Figure 2 shows the number of cellular phone subscribers in Japan. In September 1992, there were 15.5 million subscribers. Of these 1.2 million were using portable stations, suggesting that cellular units are increasingly being used as outdoor portable stations rather than mobile stations in cars.

This paper reports on the latest developments in PHP systems in step with the flourishing mobile and personal communications industries.

2. Overview of PHP system

2.1 Service concept

Figure 3 shows some of the superior features of the system.

The PHP system employs a standardized digital radio interface, allowing PHP terminals to be commonly used at home, office, or outdoors. The network registers the location of an user and tracks their movement through different exchanges, thus enabling incoming calls in addition to outgoing calls. System costs are further minimized through complete access to the ISDN network and ordinary subscriber lines.

Figure 4 explains the comparison of charge among several telecommunication services. PHP service can be provided with inexpensive charge for private use. The user rate, which includes monthly minimum charge and service charge, of PHP service is planned to range from half to one third of existing cellular telephone services. This price setting can be achieved because existing network infrastructure such as local switches, subscriver lines and CCS No.7 signaling network, etc. is fully utilized.

Figure 5 shows the effect of the introduction of PHP service on the outdoor telecommunication market. PHP services are located between existing Cellular services and public telephone services as shown in this figure. In the near future, the telecommunication service market will rapidly increase due to the appearance of various convenient services. As a result, some public telephone users will convert into PHP users due to the attractiveness of PHP services. As the tariff of Cellular services will be decreased due to the penetration of PHP systems, some PHP users will turn into Cellular users. The above discussion concludes that both PHP systems and Cellular systems will coexist and prosper.

2.2 System structure

Figure 6 shows the basic concept of the PHP system. In addition to the basic concept such as more economical charges than cellular mobile communication services, PHP provides radio access in the final 100 metres of subscriber lines.

Thus one of the key factors is to make full use of the existing network infrastructure such as exchanges, databases, subscriber lines.

In other words, one of the main objectives of PHP development is to upgrade the telecommunication service quality by providing a radio access method in addition to wired access methods such as metalic subscriber lines and optical subscriber lines.

Figure 7 shows the PHP system configuration. In the PHP system, calls are connected through the digital network via the existing subscriber lines and the exchange equipment. Enhanced authentication scheme using a cipher code is employed between a terminal and network for security.

The standardized signal interface of access line between a base-station and network is based on ISDN I-interface protocol. The adapter point for PHP, which is attached to a local digital switch, performs PHP specific functions such as signal processing for location registration, hand-over and authentication, etc.

Common Channel Signalling (CCS) No.7 network is fully utilized for transmitting information such as call control, data transfer and operation signals. A PHP Services Control Center is established in the digital network to control the operational functions unique to PHP system. As shown in this figure, intelligent function of network is fully utilized.

2.3 Standardization ; Activities and Results

The Common Air Interface (CAI) of the PHP system has been completely standardized . The Telecommunication Technology Council, a consulting organization for the Ministry of Post and Telecommunications, has made a final standard based on the radio regulation in April 1993. A frequency band width of 23 MHz (1895 - 1918 MHz) was allocated for the commercialization trial held in the city of Sapporo. This frequency band can accommodate up to 77 radio channels. The output power of not more than 10mW is settled for a PHP terminal and also for a private base-station. The output power of not more than 500 mW is fixed for a public base-station.

Table 1 shows the main features of PHP radio standards.

The Research and development Center for Radio systems (RCR) is a Japanese standardization organization for radio issues. RCR is fully responsible for producing detailed radio standards to ensure suitable quality and interconnectability. [9]

RCR carried out a verification experiment of the PHP-Common Air Interface last July, 1992 in Tokyo. 47 companies participated in this experiment. In this experiment, NTT prepared not only portable terminals, but also the base stations and those network functions for the PHP system. The participating companies could connect their terminals to digital networks. Almost all companies prepared their own PHP equipment based on the draft of standard and got successful results.

The Telecommunication Technical Committee (TTC), a standardization organization for network interface issues, completed its PHP network interface standardization in 1993. The standardized PHP network interface (between base-stations and networks) is based on a ISDN interface (I-interface). The layer-1 (physical layer), layer-2 (data-link layer) and Call Control (CC) function of layer-3 (network layer) are identical to ISDN protocol. However, application parts are modified in order to support PHP specific functions such as location registration, hand-over and authentication, etc. The PHP network interface is called as modified I- interface.

As described above, radio interface and network interface was successfully standardized. This result is very important for the cost reduction of the system and terminal implemention. The standardized specification are open to the public. [8]

3. PHP Field Trials

3.1 Outline

A first field trial of PHP system has started on the 5th, October,1993 by NTT. Trial usage of the PHP system has mainly two objectives as follows.

(1) To assess the level of acceptance and popularity among PHP users (Marketing Survey).

(2) To assess compatibility between terminals, public base stations and the digital network (Technical issues).

At this stage, NTT's plan on the trial period is half year through till Spring of 1994. The trial will involve some 35 manufacturers of communication equipment, 5 government departments and 14 telecommunications operators which form eight groups.

3.2 Objectives and Service Areas

NTT chose Sapporo, the largest city in Hokkaido island with a population of 1.1 million, for the trial since:

(1) Its geographycal and cultural independence shelters it from economic influences and other trends of typical Japanese large cities as Tokyo.

(2) The center city area is relatively small yet contains government offices, a business district and a downtown area.

(3) The population density is high.

As Tables 2 indicate, a wide range of objectives will be investigated.

The trial performed by NTT will involve some 300 base stations and 800 monitors. More than 4000 potential monitors have been recruited through newspapers and other media, indicating the high level of interest in the PHP system among the public.

Figure 8 shows the service area in Sapporo city chosen for the trial, which includes airport, universities, housing precincts and the central business district for collecting a variety of marketing and technical data.

Another seven groups are also planning commercialization trials, most of which will be conducted in around the same period. The final results of the trial will be presented in a subsequent paper.

3.3 Base-station and portable terminal

Figure 9 shows the pictures of base-station equipments on a telephone pole, face of a wall and public telephone box. This equipment is a proto-type for this Sapporo trial use and has a volume of 10 to 12 liters and weights 8 to 10 kg. A base station half this size is now under development for commercial use and further downsizing is expected. The length of the base-station antennas are 70 cm each. Two antennas are necessary for diversity reception. In the case of installation on the public telephone box, two antennas are actually connected lengthwise to achieve a diversity effect. The total length of these antennas is approximately 1.3m.

Figure 10 shows the pictures of PHP terminal for this trial use. Their weight is about 220g and volume is 150cc. A lighter and smaller terminals are now under development for commercial use.

3.4 Traffic Characteristics

Since the beginning of the trial, a variety of valuable traffic information has been collected and analyzed. these data include daily / timely variation. completion rate of outgiong/incoming call,etc. Detailed information will be presented in the conference.

4. Towards Telecommunication Service Enhancement

4.1 The future possibility of PHP services

PHP service will surely open up a new world in communication. Without a doubt, advances in semi-conductor and LSI technologies will lead to smaller and more high performance terminals. The future may well see the appearance of wireless PHP-multimedia terminals supporting facsimile and data as well as voice transmission.

At the same time development of intelligent network such as AIN (Advanced Intelligent Networks) will accelerate, bringing users a greater range and variety of network services.

As we head towards the 21st century, PHP service will revolutionize the communication industry, providing more convenient services for all. Figure 11 gives possibility of PHP services in the future.

World-wide standardization such as UPT (Universal Personal Telecommunications) and FPLMTS (Future Public Land Mobile Telecommunication Systems) is currently under investigation at ITU. The PHP system represents the first milestone for the world-wide availability of personal communication.

4-2. Enhancement of Network Access Functions

Nowadays, telecommunication terminals are getting cheaper and becoming as sophisticated as electric household appliances. They are more like electric household appliances than personal computers. This trend will definitely increase in the near future.

On the other hand, ISDN services are expected to become more popular and the networks functions will become more intelligent. Network coverage is certainly growing.

Optical fiber systems are expected to be useful as the access infrastructure. In particular, it is very important to install optical fiber subscriber lines to support visual communications applications. Broadband systems constructed with optical fiber, are not, however, strongly required for personalized communications.

"Radio access" is indispensable for Personal Communication Services as discussed above. So these access media will construct the bridge between terminals and networks as shown in Figure 12. Enhancement of access functions between the two islands will greatly contribute to the improvement of the telecommunication service quality and variety.

5. Conclusion

This paper has presented an outline of the enthusiastic development of a PHP system in Japan and the commercialization trials underway at present. The object of the PHP system is not simply to extend the mobile communications system but to provide a wide range of high-quality access method linking networks with users (i.e. terminals). We believe that PHP is a first mile-stone for the future personal communication era. [9]

Acknowledgment

The authors wish to thank all personnel in the PHP Project, NTT Customer Systems Development Department, Radio Communication Systems Laboratories and Service Development Headquarters.

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[9] K.Ogawa, K.Kohiyama and T.Kobayashi, "Towards the Personal Communication Era - A Proposal of Radio Access Concept from Japan -" ,International Journal of Wireless Information Networks (Invited paper)..

Frequency Band	1.9 GHz
Access Method	TDMA-TDD
Traffic Channels / RF Carrier	4
Modulation	$\pi/4$ - QPSK
Voice Codec	32kbit/s ADPCM
Output Power	1 0mW (Portable Station)
RadioTransmission Rate	384 kbits /sec
Channel Spacing	300kHz

Table 1. Main Features of PHP Common Air Interface

Table 2 Objectives of the trial

Objectives	Items
(1) Acceptance of service Attitude	Attitude
	Charges
	Concept of service area
	Targeting of service area
	Utilization modes
(2) Service quality and performance	Incall performance
	Hand-over performance
	Compatibility of terminals
	Maximum mobility speed
	Future features
(3) Comparison with other services	Cellular phones
	Pagers
(4) Social consensus	PHP symposium
	Demonstrations

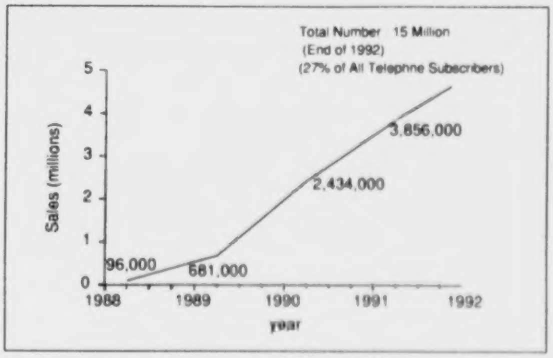

Figure1. Sales of Cordless Telephones in Japan

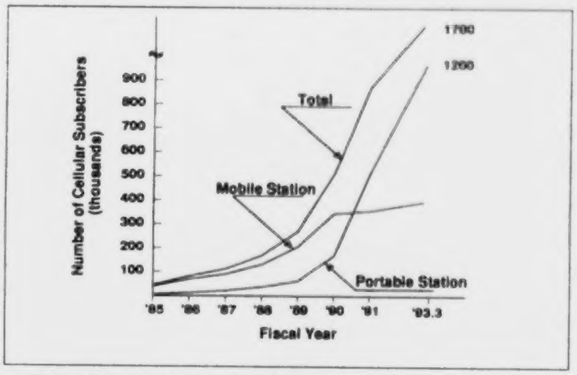

Figure2. Number of Cellular Subscribers in Japan

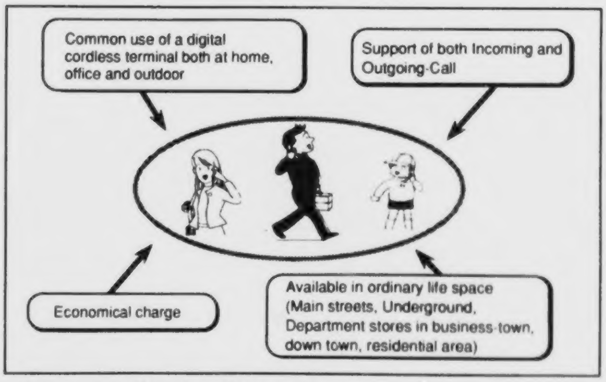
Common use of a digital cordless terminal both at home, office and outdoor
Support of both Incoming and Outgoing-Call
Economical charge
Available in ordinary life space (Main streets, Underground, Department stores in business-town, down town, residential area)

Figure 3. Service Concept

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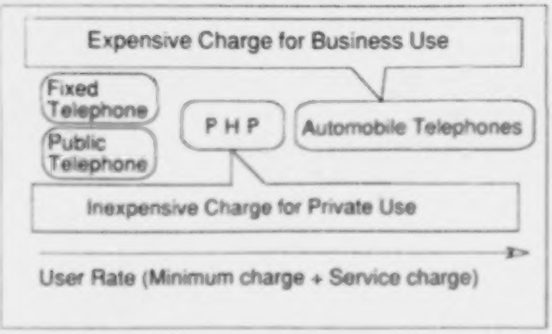
Expensive Charge for Business Use
Fixed Telephone
Public Telephone
P H P
Automobile Telephones
Inexpensive Charge for Private Use
User Rate (Minimum charge + Service charge)

Figure4. Economical Charge

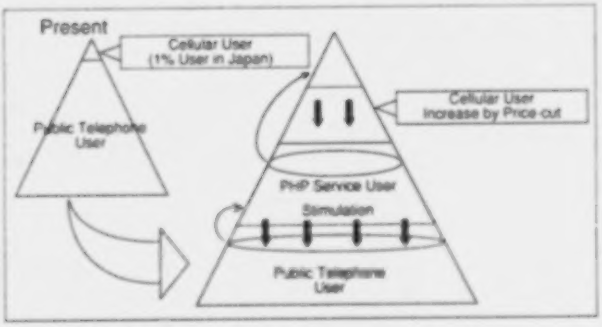
Present
Cellular User (1% User in Japan)
Public Telephone User
Cellular User Increase by Price-cut
PHP Service User
Stimulation
Public Telephone User

Figure 5. Effect on Out-door Telecommunication Market

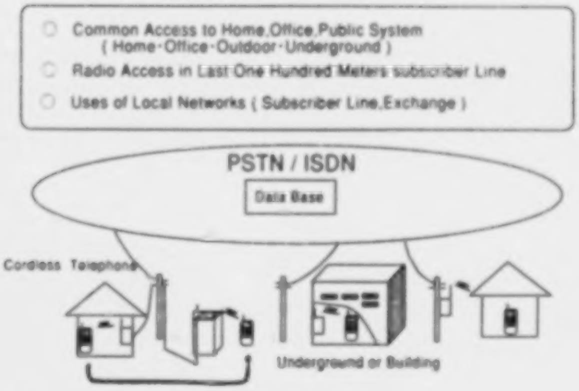
○ Common Access to Home,Office,Public System (Home·Office·Outdoor·Underground)
○ Radio Access in Last One Hundred Meters subscriber Line
○ Uses of Local Networks (Subscriber Line,Exchange)
PSTN / ISDN
Data Base
Cordless Telephone
Underground or Building

Figure 6. System Concept

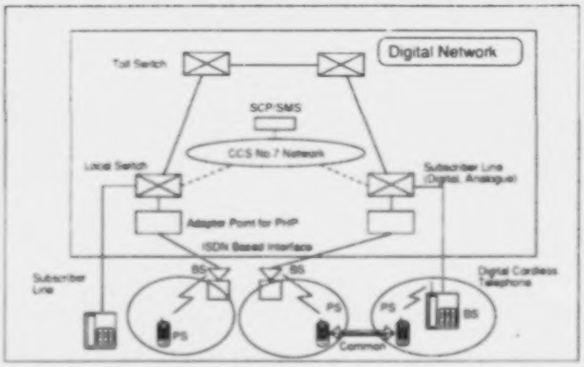
Digital Network
Toll Switch
SCP/SMS
CCS No.7 Network
Local Switch
Subscriber Line (Digital, Analogue)
Adapter Point for PHP
ISDN Based Interface
BS
BS
Subscriber Line
Digital Cordless Telephone
PS
PS
PS
BS
Common

Figure 7. System Configulation

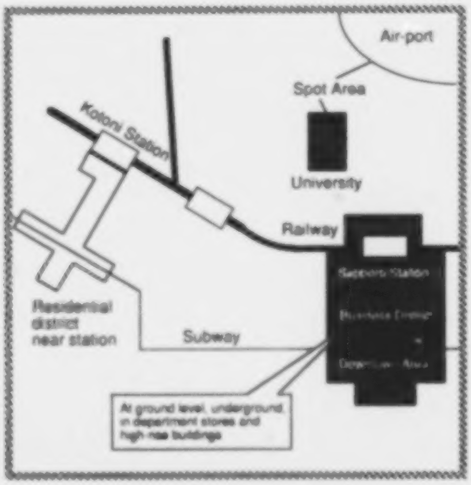
Air-port
Spot Area
Kotoni Station
University
Railway
Sapporo Station
Business District
Downtown Area
Residential district near station
Subway
At ground level, underground, in department stores and high-rise buildings

Figure 8 Service Area of the Test

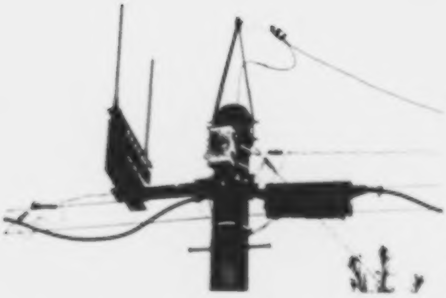

Figure 9 - 1 Base-Station (Telephone Pole)

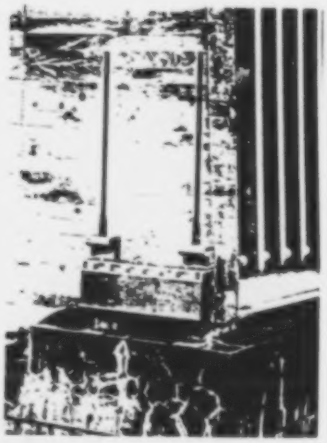

Figure 9 - 2 Base-Station (Face of a Wall)

Figure 9 - 3 Base-Station (Public Telephone Box)

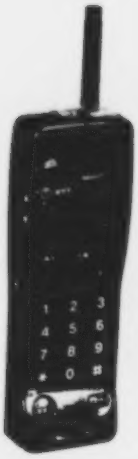
1 2 3
4 5 6
7 8 9
* 0 #

Figure 10 Personal Handy Phone Terminal

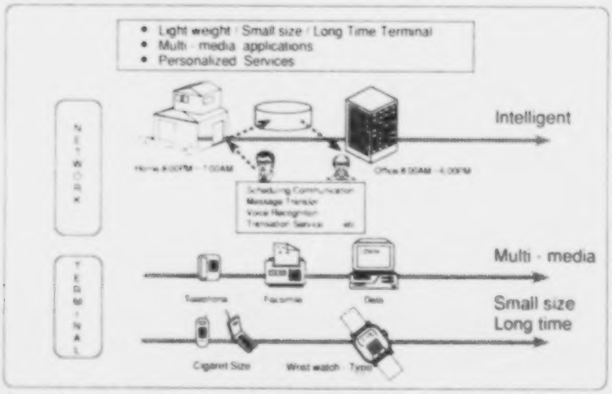
Light weight / Small size / Long Time Terminal
Multi - media applications
Personalized Services
NETWORK
Intelligent
Scheduling Communication
Message Transfer
Voice Recognition
Translation Service etc
TERMINAL
Multi - media
Telephone
Facsimile
Data
Small size
Long time
Cigarett Size
Wrist watch - Type

Figure 11 Future Direction of PHP Service

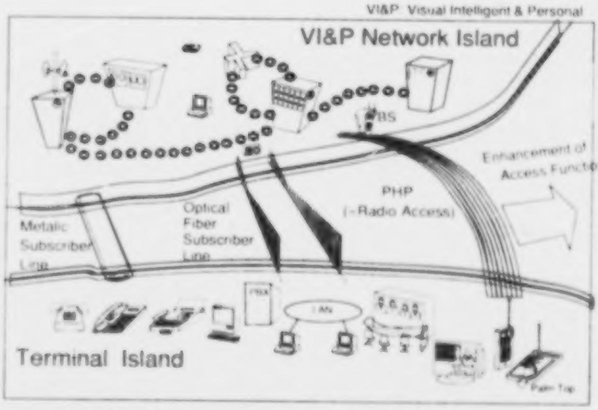
VI&P: Visual Intelligent & Personal
VI&P Network Island
BS
Enhancement of Access Function
PHP
(-Radio Access)
Metalic Subscriber Line
Optical Fiber Subscriber Line
PBX
LAN
Terminal Island
Palm Top

Figure 12 Various Access Methods to Network

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ATM Cross-connect System
—— System Architecture, Development and Field Trial ——

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Abstract An ATM cross-connect system architecture is proposed that enables the switching network to be gradually expanded according to the traffic demand without any interruption to live traffic. An optimal multiplexing scheme for the accommodation of 150 Mb/s, 600 Mb/s and 2.4 Gb/s interfaces is presented from the sense of minimum ATM switch buffer size for given a cell loss ratio. A prototype ATM cross-connect system, which is implemented based on these considerations, and its field trials are described.

1. Introduction

The ATM (Asynchronous Transfer Mode) cross-connect system provides highly reliable virtual paths (VP) [1] and realizes not only simplified and flexible networks, but also economical and operation enhanced networks. The ATM cross-connect system segregates and consolidates virtual paths based on the virtual path identifier (VPI) of ATM cells for all line interfaces mounted in the system. Moreover, the ATM cross-connect system can reroute failed virtual paths to maintain the services. Thus, the ATM cross-connect system will play an important role in constructing the future B-ISDN.

We have developed a promising ATM cross-connect architecture. Based on this architecture, we developed a prototype ATM cross-connect system that exhibits the benefits of ATM to the greatest possible extent. This system features not only very high-speed line interfaces, large capacity cross-connect switches, and built-in functions that contribute to efficient operation and maintenance, but also very compact equipment size using state-of-the-art technologies. This system is now undergoing field trials.

This paper first summarizes ATM cross-connect system requirements. An ATM cross-connect system architecture is considered that meets the requirements. The prototype ATM cross-connect system which was implemented based on the above considerations and its features are described. Finally, field trials of the system and results are presented.

2. Cross-connect System Requirements

To realize efficient operation, administration and maintenance in ATM networks, the ATM cross-connect system must satisfy the following requirements:

(1) To operate the network effectively, a large capacity VP cross-connect system is required so that any required connection can be set up.
(2) The cross-connect system should be large, and that the system should be expandable from small to large to ensure the greatest economy. When the traffic is small, a small cross-connect system is established. As traffic increases, system size should be increased without any interruption to live traffic. This feature supports the economical use of offices that range widely in size.
(3) Since the transmission bit rate depends on the traffic demand between two offices, the system must handle the various bit rate transmission lines. The cross-connect system should support SDH (Synchronous Digital Hierarchy) based 150 Mb/s, 600 Mb/s and 2.4 Gb/s line interfaces, because we have already introduced SDH transmission systems nation wide.
(4) The system throughput must be high which means that the utilization factor of the line interfaces mounted in the system must be as high as possible.
(5) To realize high performance VPs, the absolute delay and variations of the cross-connect system should be small. Moreover, cell loss and cell mis-insertion should be negligible.
(6) Since the system capacity is large, the system reliability should be high.

These requirements are satisfied by the cross-connect system architecture, high speed line transmission, and highly reliable system configurations described in the following sections.

3. ATM Cross-connect System Architecture
3.1 Line Interface Accommodation

An ATM cross-connect system should accommodate SDH based 150 Mb/s (STM-1), 600 Mb/s (STM-4) and 2.4 Gb/s (STM-16) optical interfaces according to the traffic demand. The system should use the concatenated VC-4 payload; VC-4-16c for 2.4 Gb/s and VC-4-4c for the 600 Mb/s interface. This allows the system to reduce queuing delay and increase the fill factor of transmission lines. For example, suppose that 80 Mb/s VPs are accommodated in one line. 4 VPs can be carried in 4 non-concatenated VC-4s for 600 Mb/s, while 7 VPs can be carried in one VC-4-4c.

The interface circuit packs should be designed so that each slot can accept a variety circuit packs totaling the same capacity. For example, it should be possible to replace one circuit pack containing a 600 Mb/s line with another circuit pack containing four 150 Mb/s lines. Also, four slots of 600 Mb/s or 150 Mb/s circuit packs should support one 2.4 Gb/s interface circuit pack.

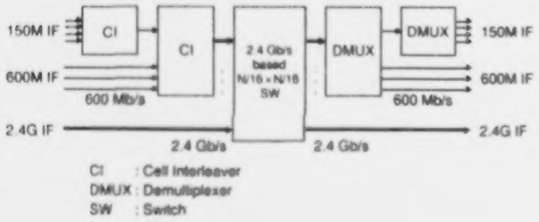

150M IF
CI
CI
2.4 Gb/s based N/16 × N/16 SW
DMUX
DMUX
150M IF
600M IF
600 Mb/s
600 Mb/s
600M IF
2.4G IF
2.4 Gb/s
2.4 Gb/s
2.4G IF
CI : Cell Interleaver
DMUX : Demultiplexer
SW : Switch

Figure 1 Type 1 multiplexing scheme

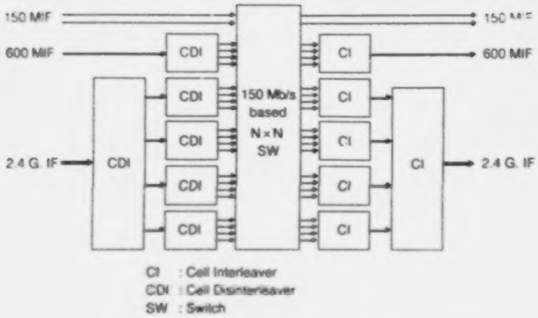

150 MIF
600 MIF
2.4 G. IF
CDI
150 Mb/s based N×N SW
CI
600 MIF
2.4 G. IF
CI : Cell Interleaver
CDI : Cell Disinterleaver
SW : Switch

Figure 2 Type 2 multiplexing scheme

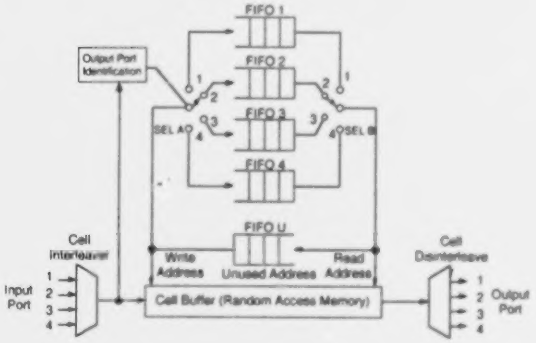

FIFO 1
FIFO 2
FIFO 3
FIFO 4
FIFO U
Output Port Identification
SEL A
SEL B
1
2
3
4
Cell Interleaver
Write Address
Unused Address
Read Address
Cell Disinterleave
Input Port
Cell Buffer (Random Access Memory)
Output Port

Figure 3 Shared buffer switch structure

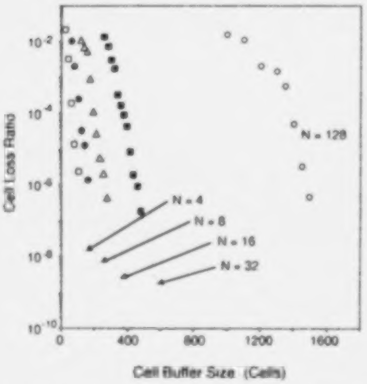
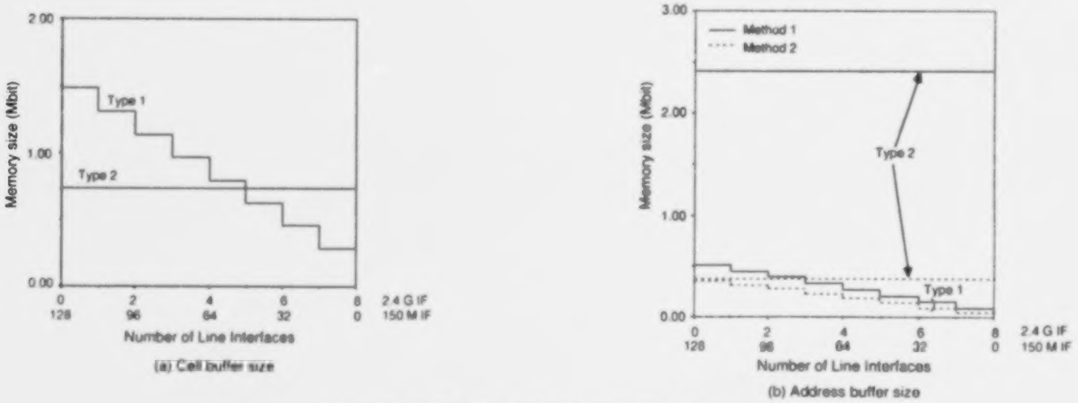


Figure 4 Shared buffer size vs. cell loss ratio



(a) Cell buffer size

(b) Address buffer size

Figure 5 Cell buffer and address buffer size

3.2 Multiplexing Scheme

This section considers the $N \times N$ buffered switch and the multiplexing scheme for accommodating 150 Mb/s to 2.4 Gb/s line interfaces. Two kinds of multiplexing schemes were considered [2]: the Type 1 scheme is shown in Figure 1 while Type 2 is shown in Figure 2. Type 1 uses a buffered switch operating at high speed and the demultiplexing stages needed to connect to lower speed interfaces. Type 2 uses a buffered switch operating at low speed and cell interleavers to connect to high speed line interfaces.

From the practical viewpoint, the shared buffer switch is very attractive [3] as the $N \times N$ switch because the queuing delay performance of the shared buffer switch complies with the M/D/1 characteristics and the required buffer is rather small.

The shared buffer switch mechanism is explained using the functional block diagram of a simple 4 × 4 shared buffer switch shown in Figure 3. The cell interleaver cyclically mul-

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tiplexes cells from the 4 input ports. SEL A selects FIFO 1, 2, 3 or 4 according to the output port information embedded within a cell. FIFO U stores unused addresses of the cell buffer. When a cell whose destination, for example, is Port 2, arrives at the cell buffer, the cell is stored in the cell buffer at the address which is obtained from FIFO U. At the same time, the address is stored in FIFO 2 and later it is used to read the cell from the cell buffer.

SEL B cyclically selects FIFO 1, 2, 3 or 4, and cells whose destination are 1, 2, 3 and 4 are output cyclically. The cell disinterleaver rotates synchronously to route cells to their destination. When FIFO 2 is, for example, selected by SEL B, a cell is read out from the cell buffer at the first address held in FIFO 2 and goes to Port 2 via the cell disinterleaver. Then the address read from FIFO 2, which is now unused, is then stored into FIFO U.

Figure 4 shows shared buffer size vs. cell loss ratio for parameter N (switch size) as obtained from computer simulations for random traffic and a port load of 0.95.

To compare the performance of Type 2 to that of Type 1, we examined a 150 Mb/s based 128 × 128 switch and a 2.4 Gb/s based 8 × 8 switch with 1:16 demultiplexer. The cell buffer (in Figure 3) size can be determined from $N = 128$ and $N = 8$ in Figure 4, respectively. The buffer size of the 1 : 16 demultiplexer used in Type 1 can also be determined from $N = 16$ in Figure 4. Two methods are considered for determining the size of the address buffers (FIFO 1, 2, 3, 4 and U in Figure 3). In Method 1, the capacity of each FIFO equals the total number of cell buffer addresses (cell buffer size). Though Method 1 does not cause cell loss due to address buffer shortage, it requires large address buffer memories. In Method 2, the capacity of each FIFO is limited to 256 addresses. The capacity of FIFO U is the same as determined by Method 1. Since 256 is less than the number of cell buffer address, cells might be lost due to address buffer shortage. 256 is the size that realizes cell loss ratios of less than 10^{-10}. The cell buffer and address buffer memory size (Method 1 and Method 2) of Types 1 and 2 are shown in Figure 5. Also, the total buffer memory size of Types 1 and 2 are shown in Figure 6.

It follows from Figure 5 that the address buffer memory of Type 2, especially with Method 1, is large because many FIFOs are required in a 128 × 128 switch. As a result, the total buffer size of Type 2 is larger than that of Type 1 as shown in Figure 6. Thus, Type 1 is more suitable when 150 Mb/s and 2.4 Gb/s line interfaces are used in equal proportions.

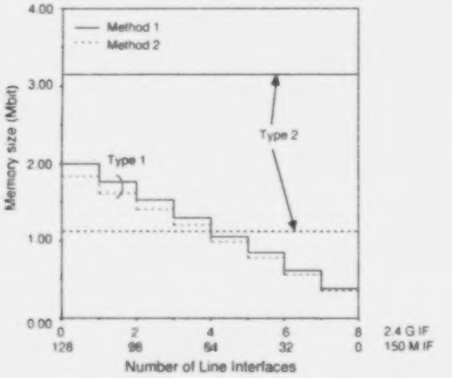

Figure 6 Total memory size of shared buffer switch

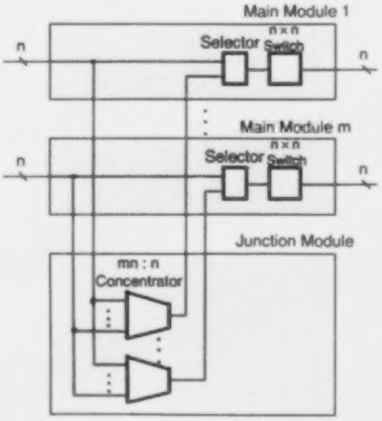

Figure 7 ATM Cross-connect architecture

3.3 Expandable ATM Cross-connect System

A large capacity ATM cross-connect system is physically made up of multiple frames or bays. To economically support small to large offices, the system should be capable of being gradually increased to match the desired office scale. Thus, we must investigate expandable switch architectures that distribute the switching function to each bay.

We propose the architecture shown in Figure 7. The system consists of Main frames and a Junction frame. The Main frame accommodates transmission line interfaces, an $n \times n$ buffered switch, and a non-buffered selector which selects the signals from the Junction frame or within the main frame. The Junction frame consists of m ($mn : n$) buffered concentrators [3] and Junction interfaces for connection to the Main frames.

When the traffic is light, only one Main frame is needed. When the traffic exceeds the Main frame capacity, one Junc-

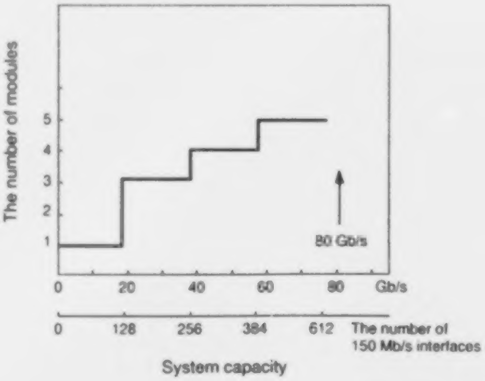

Figure 8 The number of modules vs. system capacity

tion frame and another Main frame are added. When the Junction frame is used in the system, the non-buffered selector in the Main frame switches to the Junction frame. This can be performed hitlessly because the delay is larger on the path via the Junction frame. This switch-over causes only slight cell delay variation. Up to *m* Main frames and one Junction frame can be used to support a lot of traffic.

The concentrator in the Junction frame only selects any of the *n* output ports from the *mn* input ports. It does not have to select a particular output port and deals with *n* output ports as a group. Thus, a smaller buffer is needed than is used in the usual $mn \times n$ buffered ATM switch.

When the buffered switch in the Main frame is a 2.4 Gb/s based 8 × 8 switch ($n = 8$) as described in Section 3.2, which represents a 128 × 128 switch in terms of the 150 Mb/s interface, and the 2.4 Gb/s based concentrator in the Junction frame is 32 : 8 ($m = 4$), the system can support 32 × 2.4 Gb/s interfaces or 512 × 150 Mb/s interfaces. The maximum capacity is about 80 Gb/s. The relationship between the capacity and the number of frames is shown in Figure 8.

4. High-speed ATM Line Interface

4.1 Error Detection Method

For SDH transmission lines, the BIP (Bit Interleaved Parity) is defined to monitor error performance [4]. The BIP code length increases with the line speed. When the BIP code is long, for example, a 384 bit BIP for STM-16 (2.4 Gb/s), the hardware needed to implement the error performance monitoring function becomes very large. We propose that a reduced BIP calculation be used at the receive side, while the transmission side BIP complies with the ITU-T (formerly CCITT) standard. The reduced BIP code is generated from all bits of the received BIP code. We use BIP-24, where the BIP-24 calculated from the received data information (payload) is compared to the BIP-24 code converted from the received BIP-384 code for STM-16 signals. This is shown in Figure 9.

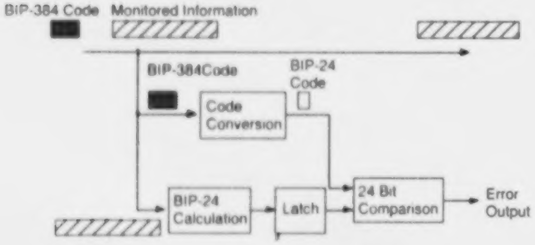
BIP-384 Code
Monitored Information
BIP-384Code
BIP-24 Code
Code Conversion
BIP-24 Calculation
Latch
24 Bit Comparison
Error Output

Figure 9 Reduced BIP calculation circuit

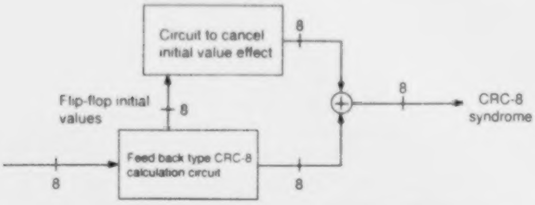
Circuit to cancel initial value effect
8
Flip-flop initial values
8
Feed back type CRC-8 calculation circuit
8
8
8
CRC-8 syndrome

Figure 11 CRC-8 calculation circuit with cancellation circuit

This method allows the use of the ITU-T standard line interface, while reducing the hardware size by about 3000 gates for STM-16 without degrading performance. This method is also effective for STM-4 (600 Mb/s) signals.

4.2 Cell Delineation

A 40 bit parallel processing operation is useful to calculate the CRC-8 defined in HEC (Header Error Control) for implementing cell delineation, because this needs no feedback. In a feedback type CRC circuit, flip-flop reset is required prior to CRC calculation. If the flip-flops of CRC circuit are not reset, the CRC calculation result is corrupted by the previous flip-flop values. Thus, a feedback type circuit cannot calculate CRC syndrome continuously without any additional circuit as described later in this section. The 40 bit parallel processing technique shown in Figure 10 is for 8 bit wide data. This allows for one byte shift search in the HEC based cell delineation, so that a cell boundary is found within one cell.

In practice, the data parallelization technique is used to reduce the operating speed. When $k \times 8$ ($1 < k < 6$) bit wide data is used, a *k* byte shift search is possible because the cell length is prime number, 53. The cell boundary can be found within *k* cells using one cell delineation circuit. If *k* cell delineation circuits, which would be rather bulky, were used, the cell boundary would be found with in one cell.

We estimated overall cell delineation times when using one circuit and *k* circuits. Overall cell delineation time is determined by the search process (Hunt to Presync state defined in ITU-T Rec. I.432 [5]) time and the confirmation process

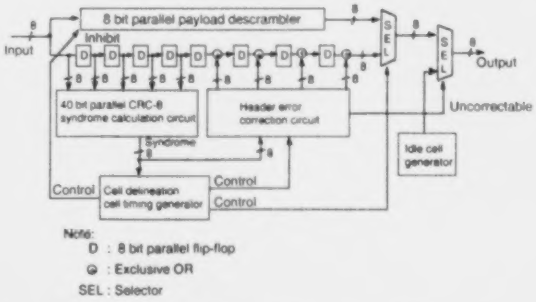
8 bit parallel payload descrambler
Inhibit
Input
8
D
8
SEL
Output
40 bit parallel CRC-8 syndrome calculation circuit
Header error correction circuit
Uncorrectable
Syndrome
Idle cell generator
Control
Cell delineation cell timing generator
Control
Control
Note:
D : 8 bit parallel flip-flop
⊕ : Exclusive OR
SEL : Selector

Figure 10 An example of cell delineation and HEC circuit

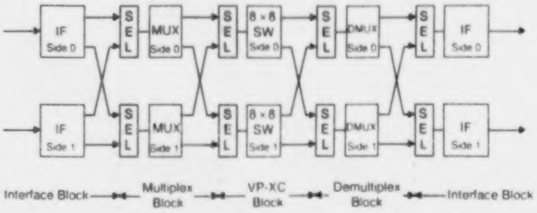
IF Side 0
SEL
MUX Side 0
8 × 8 SW Side 0
DMUX Side 0
IF Side 0
IF Side 1
MUX Side 1
8 × 8 SW Side 1
DMUX Side 1
IF Side 1
Interface Block
Multiplex Block
VP-XC Block
Demultiplex Block
Interface Block

Figure 12 System redundancy and cross-coupling

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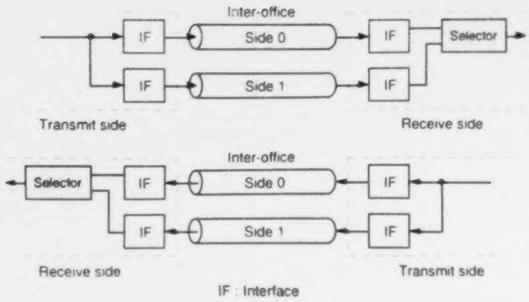

Inter-office
IF
Side 0
IF
Selector
IF
Side 1
IF
Transmit side
Receive side
Inter-office
Selector
IF
Side 0
IF
IF
Side 1
IF
Receive side
Transmit side
IF : Interface

Figure 13 (1 + 1) line protection switching function

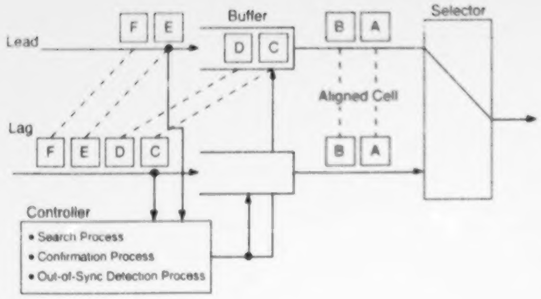

Lead
F
E
Buffer
D
C
B
A
Selector
Aligned Cell
Lag
F
E
D
C
B
A
Controller
• Search Process
• Confirmation Process
• Out-of-Sync Detection Process

Figure 14 Errorless protection switching mechanism

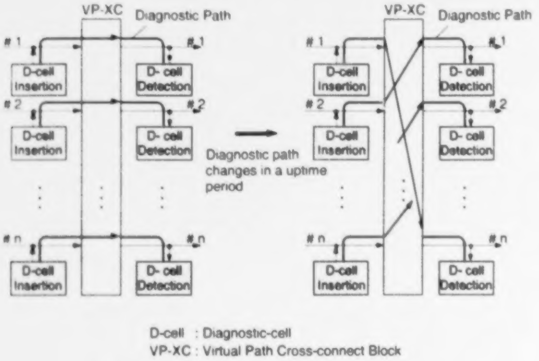

VP-XC
Diagnostic Path
#1
D-cell Insertion
#1
D- cell Detection
#2
D-cell Insertion
#2
D- cell Detection
#n
D-cell Insertion
#n
D- cell Detection
Diagnostic path changes in a uptime period
VP-XC
Diagnostic Path
#1
D-cell Insertion
#1
D- cell Detection
#2
D-cell Insertion
#2
D- cell Detection
#n
D-cell Insertion
#n
D- cell Detection
D-cell : Diagnostic-cell
VP-XC : Virtual Path Cross-connect Block

Figure 15 Diagnostics for VP-XC block

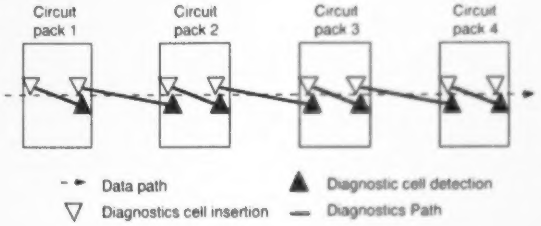

Circuit pack 1
Circuit pack 2
Circuit pack 3
Circuit pack 4
Data path
Diagnostics cell insertion
Diagnostic cell detection
Diagnostics Path

Figure 16 Double section path checking scheme

(Presync to Sync state in I.432) time. The maximum search process time is k cells for the k byte shift search method. The confirmation process time is 6 cells for all methods. Thus, maximum overall cell delineation time is $(k + 6)$ cells. The cell delineation of the one byte shift search scheme is faster $(k - 1)$ cells than the n byte shift search scheme. For example, if 32 bit wide data $(k = 4)$ are used for a 2.4 Gb/s interface so as to apply the current 0.8 μm BiCMOS technology, then the maximum overall cell delineation time is 10 cells or 1.8 μs, while 7 cells or 1.2 μs for one byte shift search. The difference is negligible with the 2.4 Gb/s interface.

There is another processing technique for calculating CRC-8 for cell delineation which is useful with 8 bit wide data. Though there is a feedback in the circuit, the effect of the initial flip-flop state is canceled and correct CRC syndromes are obtained continuously. This allows one byte shift search. Figure 11 shows the proposed CRC calculation circuit with a circuit that cancels previous flip-flop values [6]. Since the gate count of the cancellation circuit is almost same as that of the 8 bit parallel processing CRC-8 circuit, total gate count is only about twice that of the conventional feedback type CRC-8 circuit. Thus, this technique yields smaller circuit size than the 40 bit parallel processing technique for 8 bit wide data.

5. Highly Reliable System

5.1 Within Set

To achieve higher reliability and simplify maintenance, the functional blocks of the system are thoroughly duplicated. The configuration is shown in Figure 12. When a failure is detected at the working block, the working block is switched over to its stand-by block to minimize the service outage. To maintain the independence of functionality and to increase the reliability, there are some cross-couplings between the duplicated blocks. Moreover, manual switching for the blocks can be performed errorlessly so that unfailed parts in the block which are switched together with the failed part in the block are not be interrupted.

5.2 Line Protection

The line is also duplicated to enhance reliability as shown in Figure 13. When a working line is broken, the line is switched over to the protection line automatically. There is also a manual errorless switching function. When public construction such as bridge renewal is scheduled, the line needs to be switched over to the other route. At this time, the manual errorless switching function is useful to prevent customers from being bothered due to service down or service quality degradation.

The SDH automatic protection control mechanism using K1 and K2 bytes in the section overhead [4] should be adopted to connect the conventional SDH equipment. The cell delay variation should not be significantly increased by protection switching. Thus, we propose that the SDH automatic protection control be used and that the receive side align the cell streams of sides 0 and 1 by inserting delay into the lead side

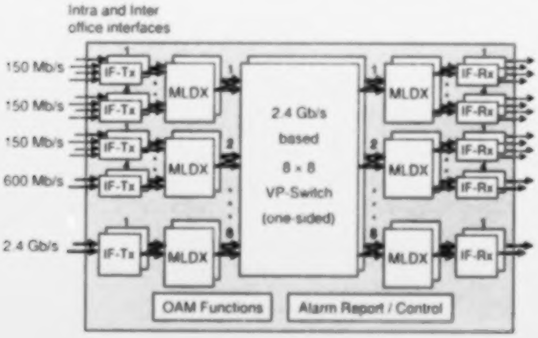
[7]. A functional block diagram for the cell alignment method is shown in Figure 14.

The proposed cell alignment method consists of search, confirmation and out-of-sync detection processes to prevent false alignment. The search process measures the distance between both sides and checks the distance N consecutive times. The confirmation process inserts the delay which corresponds to the distance measured by the search process into the lead side and checks the coincidence of side 0 and 1 M consecutive times. After the confirmation process finished, the out-of-sync detection process starts. If irregularities are detected L consecutive times in the out-of-sync detection process, the search process starts. Thus, cell streams of side 0 and side 1 are completely aligned so switching is errorless and cell delay variation is not increased.

6. System Self-Diagnostics

6.1 Local Idle Cell Utilization

System self-diagnostics is introduced into the equipment to prevent fault latency and to identify a failed circuit pack. The circuit pack in which a failure is detected by the self-diagnostics should be automatically switched over to its stand by. The failed circuit pack should be replaced by a normal one.



Intra and Inter office interfaces
150 Mb/s
150 Mb/s
150 Mb/s
600 Mb/s
2.4 Gb/s
IF-Tx
MLDX
2.4 Gb/s based 8 × 8 VP-Switch (one-sided)
IF-Rx
1
2
8
OAM Functions
Alarm Report / Control

Figure 17 ATM Cross-connect system configuration

We propose that local idle cells be used for self-checking so as not to interrupt live traffic. The ATM cross-connect system supports the SDH-based line which has the section and path overheads of 90 bytes per a frame for a VC-4 on an STM-1. Since the section and path overheads do not need to be supported within the set, local idle cells are created and used as self-diagnostics cells. An example of the self-diagnostics in the virtual path cross-connect block is shown in Figure 15. All routes of the virtual path cross-connect block can be checked by changing the destination of the self-diagnostics cells periodically.

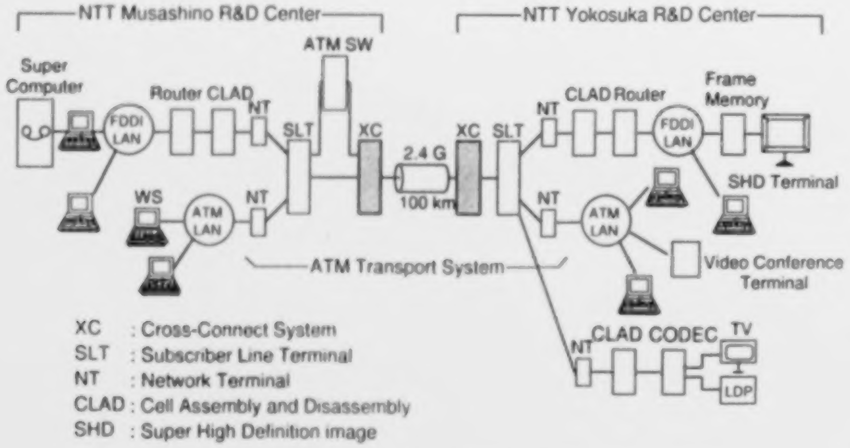
The cross-coupling selector shown in Figure 12 is checked continuously by switching over alternately when self-diagnostics cells pass through. This switching does not interrupt the live traffic because the selector selects the active side when user cells are being passed.

6.2 Double Section Path Checking

Double section path checking is proposed to make sure all parts are checked. This method is shown in Figure 16. This path check is also performed by diagnostics cells which replace local idle cells. This method checks between circuit packs and within a circuit pack using diagnostics cells. Within a circuit pack, diagnostics cells are inserted at the input edge of the circuit pack and they are captured and checked at the output edge. Between circuit packs, diagnostic cells are inserted before the output edge of one circuit pack, and then are captured and checked after the input edge of the other circuit pack. The supervision section is partly doubled, and all parts of the data path are checked.

7. Prototype System

A prototype ATM cross connect system was implemented based on the considerations given in Sections 2 to 6. The Main frame, which was described in Section 3.3, was



NTT Musashino R&D Center
NTT Yokosuka R&D Center
ATM SW
Super Computer
Router CLAD
NT
FDDI LAN
SLT
XC
2.4 G
100 km
WS
ATM LAN
ATM Transport System
CLAD Router
Frame Memory
SHD Terminal
Video Conference Terminal
CLAD CODEC
TV
LDP
XC : Cross-Connect System
SLT : Subscriber Line Terminal
NT : Network Terminal
CLAD : Cell Assembly and Disassembly
SHD : Super High Definition image

Figure 18 ATM transport system configuration for field trial

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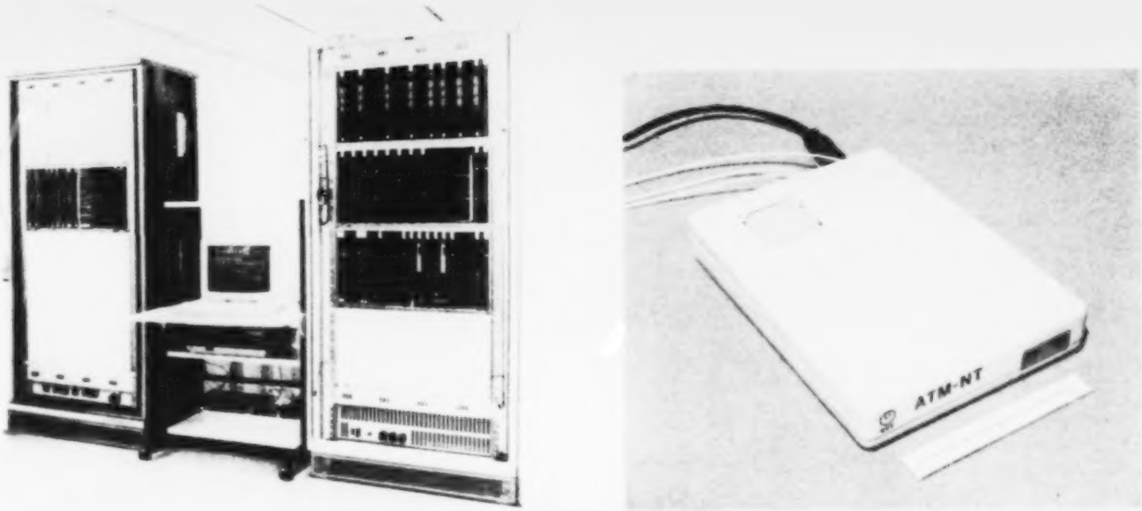

Figure 19 ATM-XC, ATM-SLT and NT

implemented as a prototype system using state of the art technologies, such as 0.8 µm CMOS, BiCMOS and GaAs VLSIs. Its block diagram is shown in Figure 17. The system has a capacity of 19.2 Gb/s per frame which is equivalent to accommodating 128 × 152 Mb/s line interfaces, or 8 × 2.4 Gb/s line interfaces. It is very compact for its capacity. We adopted the Type 1 multiplexing scheme described in Section 3.2, and the ATM cross-connect switch operates at 2.4 Gb/s as shown in Figure 1. In addition, it has very high performance; the cell loss ratio is under 10^{-10} given uniform random traffic and 95% loading.

This system supports 2.4 Gb/s (VC-4-16c) high speed line interfaces as well as 600 Mb/s (VC-4-4c) and 150 Mb/s (VC-4) line interfaces. They are interchangeable using the same shelf slots to meet network demands. The 150 Mb/s interface circuit pack mounts 4 pairs of 150 Mb/s optical receivers and transmitters and includes SDH and ATM layer processors. One 150 Mb/s circuit pack can be replaced by one 600 Mb/s circuit pack. Four 150 Mb/s or four 600 Mb/s circuit packs can be replaced by one 2.4 Gb/s interface circuit pack.

An error performance monitoring technique that uses reduced BIP (Bit Interleaved Parity) length without degrading performance has been newly developed for the 600 Mb/s and 2.4 Gb/s line interfaces to minimize hardware size as shown in Section 4.1. Cell delineation methods that use HEC and the one or four byte shift search process were implemented as described in Section 4.2. Each line has the function of automatic (1+1) protection switching, and errorless switching can be performed manually.

The system is completely duplexed, including the multiplexing and demultiplexing block and cross-connect block as well as the line interface block as described in Section 5. Self-diagnostics are introduced into the system, including VP cross-connect switch function check, protection group selector check, double section path check using local idle cells as described in Section 6

Virtual path OAM functions, such as maintenance signal transfer, virtual path performance monitoring, virtual path test, virtual path trace and cell statistic measuring functions are built into the system [8], [9]. This allows efficient and effective network operations.

8. Field Trial

ATM transport prototype systems including ATM cross-connect systems (XCs), ATM add/drop multiplexers (ADMs), ATM subscriber line terminals (SLTs) and network terminals (NTs) were implemented and have been undergoing tests since October, 1992. Figure 18 shows the field trial configuration. Figure 19 shows external views of the implemented prototype ATM cross-connect system, ATM subscriber line system and network terminal.

ATM cross-connect systems directly connect Musashino R&D center and Yokosuka R&D center using a 2.4 Gb/s line interface and 1.55 µm zero dispersion single mode fiber. The distance is about 100 km, and there is one regenerator in an intermediate office in Tokyo. ATM cross-connect systems connect SLTs with 150 Mb/s or 600 Mb/s intra-office optical interfaces.

We confirmed the VP provisioning function and VP data transfer function via all the 150 Mb/s, 600 Mb/s and 2.4 Gb/s interfaces in the ATM cross-connect system. We confirmed that ATM cross-connect performance achieves a cell loss ratio better than 10^{-10} with 0.95 random traffic on each port. We tested the automatic switching function for each duplexed block and the self diagnostics functions. We verified the hitless switching function for the 150 Mb/s, 600 Mb/s and 2.4 Gb/s interfaces. We verified the virtual path OAM functions such as maintenance signal transfer, VP test, VP trace, and VP performance monitoring. Using this ATM system, communications between FDDI LANs, between ATM LANs, and between video terminals are being conducted.

9. Conclusion

We have presented an ATM cross connect system architecture to meet the requirements. We have developed a prototype ATM cross-connect system based on architectural considerations. The developed prototype system is very compact, but its capacity for accommodating line interfaces is very large. The system achieves high throughput and high performance. The system is very reliable because it uses the (1+1) configuration for all protection groups. The system has enhanced built-in OAM functions.

A prototype system was implemented and has been undergoing field trials. This system allows networks to be more simple, to be more economical, and to offer enhanced operations. The system can support many kinds of services, such as ATM public switched circuit services and ATM private leased circuit services.

The operation architecture is not dealt with in this paper for space reasons. The operation interface is now local, but we are now developing Q3 interfaces to meet the TMN concepts.

Acknowledgment

The authors thank Dr. Tetsuya Miki and Dr. Haruo Yamaguchi for their helpful suggestions.

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An Expandable Non-blocking ATM-crossconnect Architecture for Large Capacity

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Abstract

ATM crossconnect or switching technique is the key to construct the next generation of telecommunication networks, or B-ISDN. This paper describes the ATM crossconnect architecture with non-blocking and expendability. The proposed architecture consists of two types of switch fabrics, the element module and connecting module. The architecture is characterized by crosspoint-placement distributed shared buffers for both modules and grouping controlled mechanism for the connecting module, which enables to construct non-blocking large-capacity crossconnect systems with less hardware. Based on the above architecture, we developed prototype ATM transport systems consisting of ATM trunk systems (crossconnect system) and ATM subscriber access systems (add-drop multiplexer and subscriber line terminal), for which newly developed LSIs and high-performance cooling technique were applied.

1. Introduction

The key feature of B-ISDN is its unique transfer mode, called the asysnchronous transfer mode (ATM), which can effectively integrate services with different bit rates, such as voice, high-speed data, and video. In order to handle B-ISDN services with different requirements in quality and bandwidth, vigorous efforts are being made by the ITU-TS (CCITT) [1].

The virtual path (VP) concept has been proposed for ATM networks [2], and expected to play a key role in the introduction of B-ISDN [3]. ATM transport systems based on the virtual path concept, including crossconnect systems (XCs) and add-drop multiplexers (ADMs) have been studied [4], [5] and their first application will provide cost-effective, flexible multimedia leased-line services [4].

An expandable non-blocking ATM crossconnect architecture is essential to the above VP-based ATM transport networks with trunk and subscriber access networks for the introductory stage to the mature stage of B-ISDN. Many studies for switching architectures to meet with such demand have been promoted worldwidely [6], [7].

In this paper, we propose the expandable non-blocking crossconnect architecture for the VP switch with high performance and less hardware. And the proposed architecture were successfully applied to prototype ATM transport systems including XCs for trunk systems and ADMs and subscriber line terminals (SLTs) for subscriber access systems.

2. ATM transport system

B-ISDN is originally intended to provide multimedia services. In order to meet changes in service, media, and communication methods, and also to realize economical multimedia services for leased-line services, a flexible and reliable network architecture is required. A flexible and reliable network on the basis of the VP architecture can be constructed on the non-blocking VP-switch architecture.

Fig. 1 shows a flexible ATM transport network based on the VP-switch for B-ISDN.

XCs are used in trunk networks to handle high-capacity traffic and to provide flexible virtual path networks. Here, path connection and path capacity allocation are designed independently. A cell-based multiplexing scheme enables non-hierarchical crossconnect capabilities and provides simple crossconnect mechanisms for network elements.

The subscriber access network consists of ADMs, SLTs, and NTs. The SLT has the function of line concentration and policing of ATM cells. The ADM has the add-drop function and provides flexible VPs between SLTs and between SLT and Switching node (SW) according to the user's requirements. High-speed optical transmission links are shared by ADMs and the flexible bandwidth of VPs can be allocated between ADMs. The VP path connection and bandwidth allocation are flexibly changed when a failure occurs, to ensure high reliability. Dual ring architecture and loopback functions are therefore necessary for a ring-based network.

In the above network elements such as XC, ADM, and SLT, flexible VP path setting and path restoration can be performed by the VP-switch. Non-blocking characteristics of the VP-switch will facilitate these functions and provide easy operability of path management. And the VP-switch are required for variety of capacities from small size to large size. For example, 2.4 Gb/s throughput for SLT, 4.8 Gb/s throughput for ADM, and 20 Gb/s throughput for XC are required. In mature stage of B-ISDN, XC systems with larger capacity more than 100 Gb/s throughput will be required.

Therefore, the expandability and non-blocking of the VP-switch are considered as key factors to configure the VP-based networks.

3. Expandable non-blocking crossconnect architecture

In this paper, we propose the expandable non-blocking crossconnect architecture for the VP switch with high performance and less hardware.

Our proposed crossconnect architecture (Fig.2) consists of two types of switch fabrics. One is the element module with the crosspoint-placement distributed shared-buffers (CPSBs). The other is the connecting module with grouping-controlled CPSBs for connecting multiple element modules. Here, expandability is based on modularity of crosspoint-placement architecture, non-blocking is assured by matrix switch configuration, and high-performance and less hardware are performed by buffer-sharing and grouping control.

The element module is applicable for one-bay system with optical international standard interfaces such as STM-1, STM-4c, and STM-16c, and with limited capacity, for example, less than 20 Gb/s throughput.

The connecting module can facilitate to configure large capacity crossconnect systems with multiple element modules. In corresponding to demand of larger capacity, element modules are connected to the connecting module one by one. ATM cells received in the interfaces of each element module are transmitted to the connecting module, and routed to the destinated element module via the VP-switch in the connecting module. Received cells from the connecting module are inputted to the VP-switch in the element module, crossconnected, and routed to the destinated interface.

The details are described below. Noted that the proposed architecture is basically independent of its implementation speed and technologies.

3.1 Element module

The switch fabrics are classified by their buffer placement. Crosspoint buffered switch has the advantages of modularity for large capacity and expandability, high-speed operation due to relaxed synchronization of signals, and easiness of buffer control/management, although it has required large buffer memory for large size of switch. Shared-buffer switch gives efficient buffer memory utilization and required less memory, though switching capacity is limited by the memory access speed and the complexity of buffer control/management.

Based on the above, we propose that the switch fabric for the element module consists of distributed shared-buffers at the crosspoints, which gives high-throughput under diversified traffics.

Fig. 3, for example, shows the configuration of 2x2 shared-buffer switch element. It consists of tag checkers, multiplexer, demultiplexer, dual-port RAM, buffer read/write controller, pointer buffers, and a cell copy controller. The switch writes an input cell with matching tag to the dual-port RAM and writes its address pointer to the pointer buffer according to the requested output port. On the cell reading, the switch reads out the stored cell from dual-port RAM according to the stored address pointer. The cell copy function provided for ADM is performed by writing the address pointer to two pointer buffers.

By using the above 2x2 switch elements with crosspoint placement, we can easily configure the expandable switch element module. Fig. 4 shows the switch element module, which constitutes a 2x2, 4x4, or 8x8 matrix switch. Contention resolution is performed by FIFO control (First-in first-out service basis).

Fig. 5 shows the required buffer length for a 8x8 switch with uniformly loaded inputs and random traffic. Thanks to buffer sharing, required total buffer length to maintain the same cell loss rate is reduced to about 44 %, which contributes to less hardware of the element module.

3.2 Connecting module for large capacity

We propose a larger switch configuration based on crosspoint placement of shared buffers, which offers high performance using less hardware. The target throughput of switch capacity is more than 100 Gb/s, although the above-mentioned element module is applicable for up to 20 Gb/s. The element module is appropriate as a stand-alone switch accommodating optical interfaces and SDH/ATM layer termination functions in one bay or frame.

The connecting module is a switch fabric for transportation between multiple element modules. As a whole, multiple element modules and one connecting module constitute a large non-blocking switch. On the viewpoint that the routing paths from the connecting module to each element module can be shared with the physical transmission lines, switch outputs of the connecting module are divided into groups of m lines each. Here, the size of each element module is $M \times M$ switch, that of connecting module is $N \times N$ switch, $N = k \times M$, and $m = M/j$ (k, j ; intejer). In ideal case, $m = M$.

Fig. 2 shows the expandable switch architecture composed of element modules with CPSBs and a connecting module with grouping controlled CPSBs.

Grouping controlled switch for the connecting module features that the equivalent of m times speed-operation for cells read from CPSBs can be attained. As such, the required buffer size and cell delay are less than that for the switch without grouping control. The preservation of cell sequence integrity in grouped switch outputs is attainable by FIFO control for CPSBs and reading from CPSBs the cells that arrived earlier at the switch inputs and sending to a smaller numbered switch output port in each group.

To survey the effect of grouping control for CPSBs, we studied the 8×8 switch using the shared-buffer 2×2 switch elements on grouping line number of m = 2. Fig. 6 (a) and (b) show the simulation results, considering highly loaded on specific inputs with random traffic, for required buffer length and cell delay respectively. The required buffer length and cell delay can be reduce to about 1/4 and 1/2 respectively by using grouping control. Generally, cell delay can be reduced to about 1/m.

A connecting module with grouping controlled CPSBs is, therefore, regarded as the greatly effective switch architecture to construct a large-scale crossconnect system coping with the demands of B-ISDN.

4. Prototype systems

The proposed expandable non-blocking crossconnect architecture are applied to fabricate prototype systems. Prototype systems are configured with the ATM-XCs and STM/ATM converters (SACs) for trunk systems, and ATM-ADMs, ATM-SLTs, and ATM-NTs for subscriber access systems. Main functions are listed in Table 1.

A flexible modular approach is adopted in order to realize cost-effective equipments as shown in Fig. 7. An expandable switch architecture alleviates modular approach. Each building block consisting of the printed circuit boards including newly developed LSIs is commonly used for each equipment as much as possible.

4.1 Equipment configurations

The equipment configuration and photograph of XC are shown in Fig. 8 and 9 respectively. Main function blocks are duplicated: line interface (INF), multiplexer/demultiplexer (MUX), and VP crossconnect switch (VP-SW). Hitless switching functions are installed for duplicated line interfaces and function blocks [8], [9]. For the SLT, a usage parameter control (UPC) function which monitors the exact traffic and enforces cell discarding for the assignment of network resources [4], [10] is also installed in the subscriber line interface.

The equipment management is performed by four types of processor units: a control processor unit (CONT), an OAM cell processor unit (OAM), an alarm processor unit (ALM), and supervisory processor units (SVs). Each SV works as a sub-processor for both CONT and ALM, and communicates with those two units on individual 10 Mb/s Ethernet links. These processors provide principal functionalities as alarm report, VP setup, VP trace, Cell traffic monitoring, VP continuity checking, VP performance monitoring, automatic protection switching, alarm/fault detection etc..

4.2 LSI Technologies and cooling system for printed circuit board

ATM transport systems require a high-speed cell switch for the crossconnect and add-drop functions, cell multiplexer/demultiplexers, SDH/ATM terminations, and optical transmitter/receivers for 156 Mb/s, 622 Mb/s, and 2.4 Gb/s. To realize the above functions, we developed LSIs using 200k-gate CMOS gate arrays (0.8 μm) for 52 Mb/s or slower operation, 160k-gate Bi-CMOS gate arrays (0.8 μm) for 156 Mb/s, 30k-gate GaAs gate arrays (0.8 μm) for 311 Mb/s (partially operated at 620 Mb/s), and full-customized GaAs LSI chips for 2.4 Gb/s operation. The power consumption of GaAs gate arrays is 1/3 that of ECL gate arrays, which makes a good choice for low power use. The gate scale per chip is 5 - 10 times greater than that of the SDH transmission LSIs [11].

Many FIFOs (dual port RAMs) are also required for buffering cells in ATM transport systems. Sophisticated high-speed and low-power FIFOs were developed: Bi-CMOS FIFOs that can operate at over 80 Mb/s and GaAs FIFOs that can operate at over 200 Mb/s. The gate arrays described above include these new FIFOs.

4.2.1 Switch LSI

As described in section 3, the same non-blocking switch with copy function is commonly used for each equipment. A 2×2 shared buffer switch LSI for the non-blocking switch function was developed using the Bi-CMOS gate array, as shown in Fig.10. The main features are listed in Table 2. The throughput of each port is 2.4 Gb/s (156 Mb/s × 16) and the total throughput of this LSI is therefore 4.8 Gb/s (156 Mb/s × 32). The copy function is used for the ADM.

4.2.2 VP-switch board

We developed high efficient cooling system using heat pipes for printed circuit boards, which mounted the above switch LSIs. Fig. 11 shows the VP-switch board with two

409

switch LSIs, which constitutes 4×2 cell switch. Heat pipes used in this system are minute diameter type of ∅ 3 mm, and formed flat by press in order to make the entire cooling system thin. This cooling system using heat pipe allows two times higher density circuit package than usual, and the power consumption of one LSI is allowed five times higher than usual, which means to allow 15 W of power consumption of one LSI in the book-shelf type mount form [12].

5. Conclusion

An expandable non-blocking crossconnect architecture for B-ISDN transport systems has been proposed. The proposed architecture features with crosspoint-displacement distributed shared-buffers and grouping technique. The architecture is basically free from its implementation technologies. Therefore, expandable crossconnect systems with larger capacity can be constructed as higher speed and larger-scale integrated LSI technology can be applied.

This architecture has been successfully applied to prototype transport systems consisting of ATM trunk systems (XC) and ATM subscriber access systems (SLT, ADM). The proposed architecture allows a flexible modular approach for each equipment to realize a low cost. The high-speed ATM LSI chip-set including cell switch, SDH/ATM termination, and cell multiplexer/demultiplexer, which are commonly used for each equipment, has also been developed for the prototype system. And new high-performance cooling system were also developed for high density printed circuit boards.

These equipments achieve a good performance in the experiments and these experimental results showed the proposed architecture to be a powerful tool for the realization of the B-ISDN transport networks.

Acknowledgments

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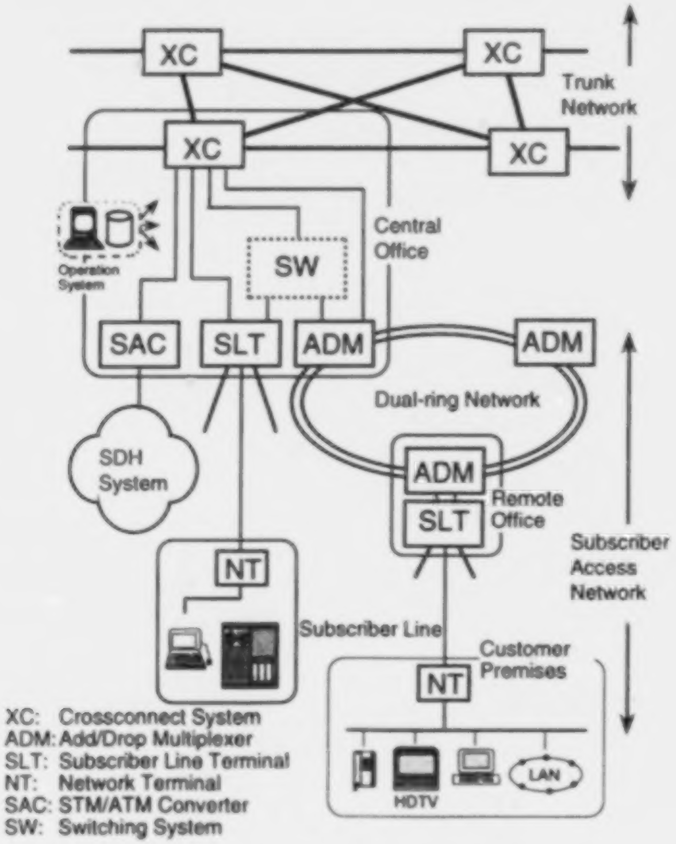
Table 1 Main functions for ATM transport systems

<table>
<tr><th>Specifications</th><th colspan="2">Trunk Systems</th><th colspan="3">Subscriber Access Systems</th></tr>
<tr><th></th><th>X C</th><th>SAC</th><th>ADM</th><th>SLT</th><th>N T</th></tr>
<tr><td>Total throughput</td><td>20 Gb/s</td><td>—</td><td>10 Gb/s</td><td>5 Gb/s</td><td>—</td></tr>
<tr><td>Transmission line rate (Topology)</td><td>2.49 Gb/s
622 Mb/s
156 Mb/s</td><td>—</td><td>2.49 Gb/s (Dual-ring)</td><td>156 Mb/s (WDM)</td><td>156 Mb/s (WDM)</td></tr>
<tr><td>Connection mode</td><td>1 : 1</td><td>1 : 1</td><td>1 : 1
1 : n</td><td>1 : 1</td><td>—</td></tr>
<tr><th>Non-stop functions</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>Transmission line interface</td><td>1 + 1
Hitless protection switching</td><td>—</td><td>Ring loop-back</td><td>—</td><td>—</td></tr>
<tr><td>Intra-office interface</td><td colspan="4">1 + 1
Hitless protection switching</td><td>—</td></tr>
<tr><td rowspan="3">Equipment</td><td colspan="4">Duplicated function blocks (Interface / Multiplexer / Switch / Controller etc.)
Hitless protection switching</td><td>—</td></tr>
<tr><td colspan="4">In-service self-diagnostics / VP provisioning / VP OAM</td><td>Self-diagnostics</td></tr>
<tr><td colspan="2">—</td><td>Hitless ring protection</td><td>UPC</td><td>—</td></tr>
</table>

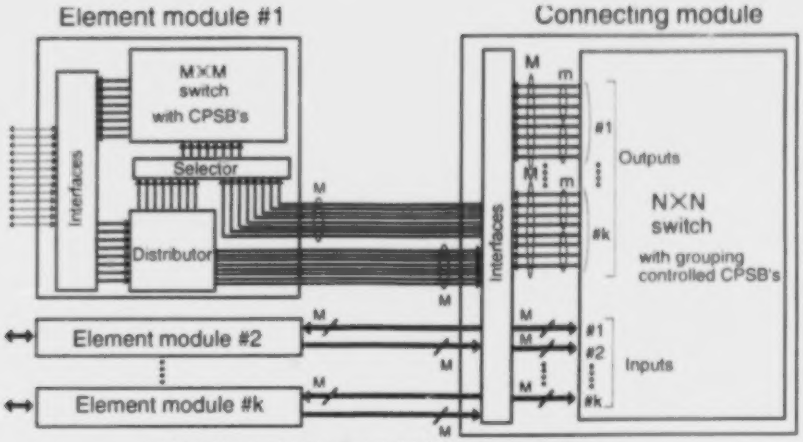
Table 2 Main features of the switch LSI

Function	Cell switch (1:1, 1:n) Traffic monitoring/control
Switch size	2 x 2 shared-buffer switch
Total throuput	4.8 Gb/s
Highway throuput	2.4 Gb/s (156 Mb/s × 16 parallel)
Device	Bi-CMOS (32 kgate + 81 kbit RAM)
I/O interface	TTL/ECL
Power consumption	12 W
Package	396-pin QFP (0.36 mm pin-pitch)


XC
XC
Trunk Network
XC
XC
Operation System
Central Office
SW
SAC
SLT
ADM
ADM
Dual-ring Network
SDH System
ADM
SLT
Remote Office
Subscriber Access Network
NT
Subscriber Line
Customer Premises
NT
HDTV
LAN

XC: Crossconnect System
ADM: Add/Drop Multiplexer
SLT: Subscriber Line Terminal
NT: Network Terminal
SAC: STM/ATM Converter
SW: Switching System

Fig. 1 Flexible ATM transport network


Element module #1
Connecting module
M×M switch with CPSB's
Interfaces
Selector
Distributor
M
M
m
#1
Outputs
#k
N×N switch
with grouping controlled CPSB's
Element module #2
Element module #k
#1
#2
#k
Inputs

CPSB : Crosspoint-Placement distributed Shared Buffers
m : Grouping line number; m = M / j , j = integer

Fig. 2 Expandable crossconnect architecture

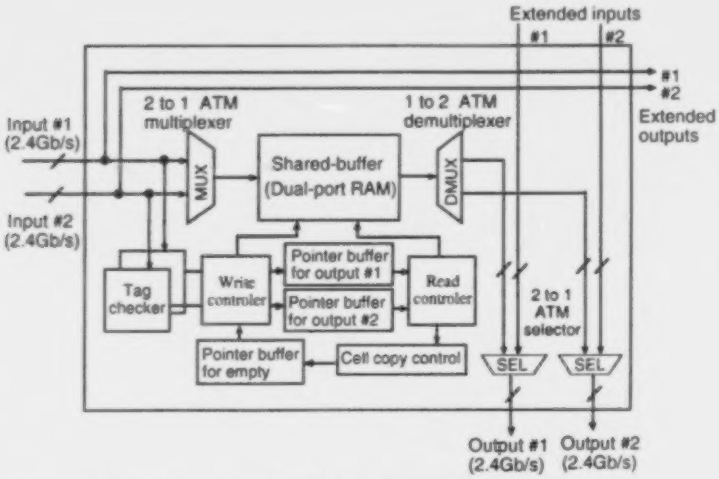
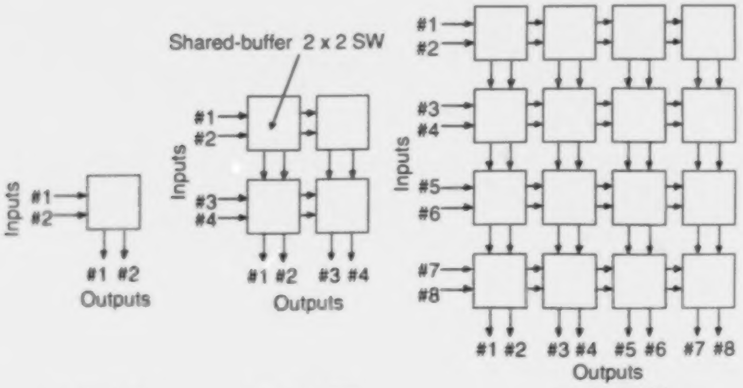

Extended inputs
#1
#2
#1
#2
Extended outputs
2 to 1 ATM multiplexer
1 to 2 ATM demultiplexer
Input #1 (2.4Gb/s)
Input #2 (2.4Gb/s)
MUX
Shared-buffer (Dual-port RAM)
DMUX
Tag checker
Write controler
Pointer buffer for output #1
Pointer buffer for output #2
Read controler
Pointer buffer for empty
Cell copy control
2 to 1 ATM selector
SEL
SEL
Output #1 (2.4Gb/s)
Output #2 (2.4Gb/s)

Fig. 3 Configuration of shared-buffer 2x2 switch element


Shared-buffer 2 x 2 SW
Inputs
#1
#2
#3
#4
#5
#6
#7
#8
Outputs
#1 #2
#3 #4
#5 #6
#7 #8

(a) 2 x 2 SW (b) 4 x 4 SW (c) 8 x 8 SW

Fig. 4 Switch element module

BEST COPY AVAILABLE

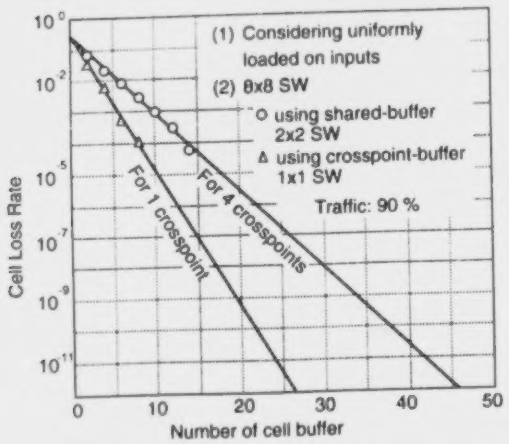
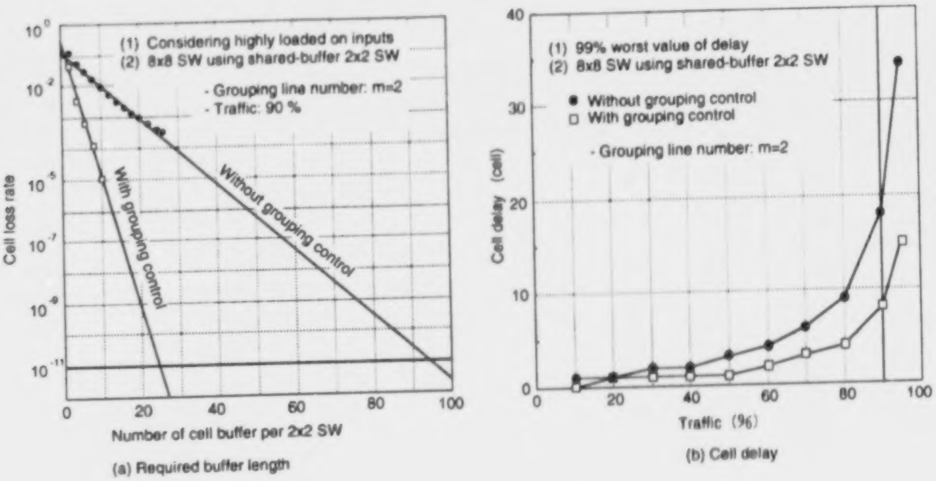


Fig. 5 Required buffer length for element module



(a) Required buffer length

(b) Cell delay

Fig. 6 Throughput characteristics (grouping effect)

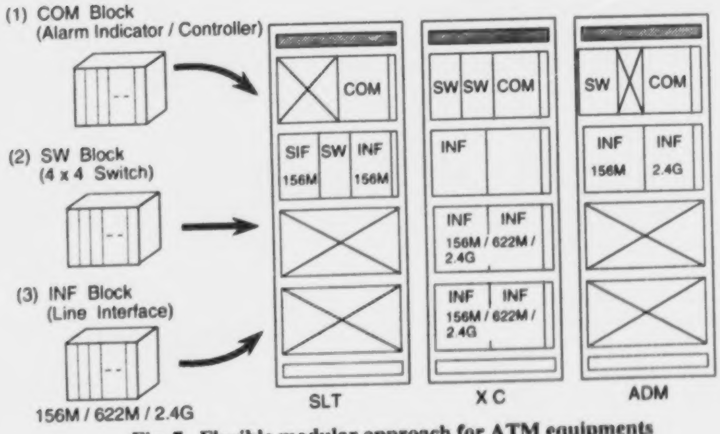

(1) COM Block
(Alarm Indicator / Controller)
(2) SW Block
(4 x 4 Switch)
(3) INF Block
(Line Interface)
156M / 622M / 2.4G
COM
SIF 156M
SW
INF 156M
SLT
SW
SW
COM
INF
INF
INF
156M / 622M / 2.4G
INF
INF
156M / 622M / 2.4G
X C
SW
COM
INF 156M
INF 2.4G
ADM

Fig. 7 Flexible modular approach for ATM equipments

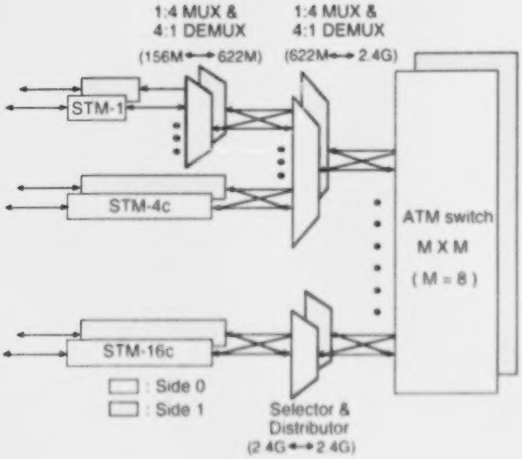
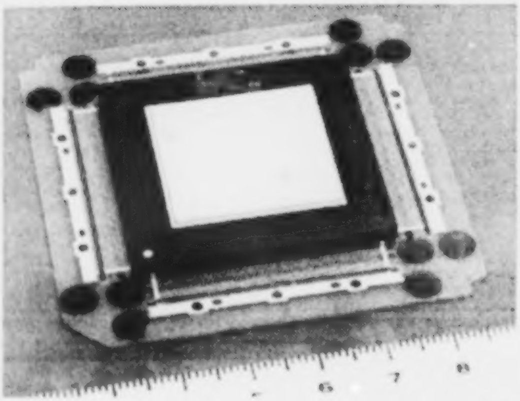

1:4 MUX &
4:1 DEMUX
(156M ↔ 622M)
1:4 MUX &
4:1 DEMUX
(622M ↔ 2.4G)
STM-1
STM-4c
STM-16c
ATM switch
M X M
(M = 8)
□ : Side 0
□ : Side 1
Selector &
Distributor
(2.4G ↔ 2.4G)

Fig. 8 Crossconnect system configuration



(Scale in cm)

Fig. 10 4.8 Gb/s throughput switch LSI (Bi-CMOS)

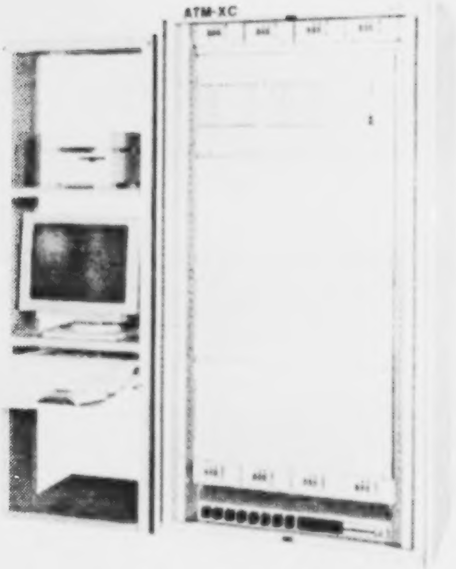
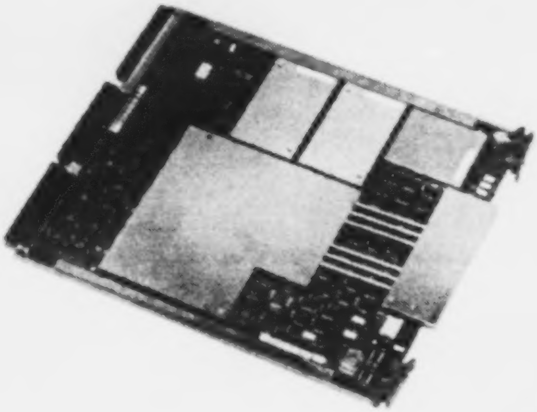


Fig. 9 ATM crossconnect (XC) prototype



(300 × 330 mm)

Fig. 11 VP-switch board (4 × 2 SW)

Strategic Enablers of the Multivendor Integration Architecture

Bo Erden and Stephen Young
Digital Equipment Corporation
Littleton, Massachusetts, USA

This paper describes the Multivendor Integration Architecture initialed by NTT and developed by NTT in conjunction with a number of international corporations including Digital. The paper covers the architecture, relation to standards, and the benefits to both users and vendors.

Why MIA

To realize their objectives for open software users are taking a more active role in the for standardization process. Large vendors who have traditionally borne the brunt of the costs of voluntary standards are downsizing. Users now have to plan for implementing standards in their systems and adopt procurement policies based on these standards, as well as enforce the. The vendors, in turn, must get contracts for standard software in order to receive a return on their investment in standards-compliant software.

Digital joined MIA in recognition of the more active role of users in defining and adopting open software standards, and to establish a good, long-term relationship with one of its big customers.

Multivendor Integration Architecture (MIA)

The Multivendor Integration Architecture (MIA) is a profile of international and *de facto* standards providing application portability and interoperability across a variety of vendors' operating systems and hardware platforms. In certain instances where suitable standards did not exist, new open technologies have been developed.

MIA provides the basis for open client-server systems for general purpose computing. Key MIA technologies are being adopted by X/Open and SPIRIT.

Five of the largest computer vendors in the world (Digital, Fujitsu, Hitachi, IBM, and NEC) have publicly endorsed MIA to date. SPIRIT includes major European, North American, and Asian telecommunications companies as well as Bull, Digital, Hewlett-Packard, and IBM

MIA Overview

MIA achieves application portability and interoperability across multiple operating systems and platforms by using standardized Application Programming Interfaces (APIs) as integrative constructs, and using standardized Systems Interconnection Interfaces (SIIs) for communication

Workstations serve as clients. PCs can be integrated via the SII and Interactive Processing Extensions (IPE). Departmental Computers are used to integrate non-MIA compliant legacy applications. Hosts function as servers for MIA applications.

By integrating on the API level, programmers can develop applications on whatever system offers the best development environment. The Inter-environment Information Interchange Interface (IIII) defines application program and data exchange formats. After a MIA application is developed once, it can be deployed on any MIA-compliant system, regardless of operating system or hardware platform. Training and maintenance are greatly simplified.

By integrating on the API level, the MIA architecture makes it possible for programmers and users to concentrate on applications answering business and governmental needs rather than problems pertaining to operating system or communication network idiosyncrasies. Applications are not disrupted by change in the underlying platforms.

Standardizing on a level of abstraction above the operating system simplifies system integration. Applications can communicate across platforms without knowledge of the underlying operating systems or hardware.

MIA and Standards

The MIA Consortium adopted existing international and *de facto* standards wherever possible. A full listing of the standards profiled by MIA can be found in ***Technical Requirements: Multivendor Integration Architecture Version 1.1*** (11 Volumes, London, New York, and Tokyo, 1992).

SII			
	OSI TP	OSI TP	ISO IS 10026
	MHS X.400	Mail:MHS	ISO 1--21-1, CCITT X.400
	FTAM	OSI FTAM	ISO 8571
	TCP/IP	TCP/IP	Internet Protocol Suite
	FTP, SMTP, TELNET		
	SNMP, UDP		
	X.25	PSN	ISO 8208, CCITT X.25
	ISDN	ISDN	CCITT I Series
	Ethernet	Ethernet	ISO 8802.3, IEEE 802.3
	MIA TP Protocol (RTI)	Basis for X/Open's TxRPC (S218)	
API			
	COBOL		
	FORTRAN	COBOL	ISO 1989-1985 & ANSI
	C	FORTRAN	ISO 1539-1980 & ANSI
	SQL	C	ANSI X3.159-1989
	STDL	SQL	ISO 9075
		No Standard Established	
HUI			
	OSF/Motif	X-Windows	ANSI BSR X3.196-199x
	IBM/CUA	*No Standard Established*	
	Open Look	*No Standard Established*	
IIII			
	MIA IFDL	FIMS subset	ISO SC22/CD11730

In some cases existing standards were incomplete. For example, no sufficient protocol existed for handling transaction processing in terms of data transfer and two-phase commit. OSI TP provides two-phase commit but no data transfer protocol. OSF RPC provides a data transfer protocol, but no two-phase commit.

In this case, the MIA Consortium created an open Remote Task Invocation (RTI) protocol specification that in effect layered the OSF Remote Procedure Call (RPC) on top of OSI TP. The RTI interface was defined for the OSI stack in 1991. Additionally, RTI extensions have been published for the IP stack (by Digital Equipment Corporation and NTT, 1992) and the LU6.2 stack (by IBM and NTT, 1992).

X/Open has published a document closely based on the MIA RTI: ***Distributed Transaction Processing: The TxRPC Specification*** (December, 1992, X/Open Document Number S218). Although this document is still a Preliminary Specification, changes from MIA RTI to X/Open's final TxRPC are expected to be minor.

Another example of the insufficiency of existing standards can be seen in the problems associated with C and COBOL. COBOL standards and C standards do not allow you to share data between COBOL and C. The standards outside of MIA do not address the issue. The MIA profiles of C and COBOL standards eliminates vendor-dependent characteristics and extensions, and defines usage restrictions to overcome this problem.

In other cases standards did not exist: for example, there was no standard for a Transaction Processing (TP) application programming interface. In this case, the MIA Consortium defined a new open standard, the Structured Transaction Definition Language (STDL). STDL is currently progressing in the SPIRIT consortium. STDL is expected to be formally introduced into the international standards process in the near future.

MIA Transaction Processing

Although MIA provides fully functional standards profiles for interactive and batch processing as well as transaction processing, MIA TP merits special attention as a significant step forwards in laying the infrastructure foundation for integration of multivendor systems.

MIA provides for open TP on a variety of hardware and operating system platforms by using STDL as an integrative API. STDL insures that TP applications will be distributable, portable, and interoperable on different vendor platforms.

The TP application model is based on separation of processing and flow control. Application transaction and flow control are handled by STDL. Systems communicate with other systems at the STDL level via RTI. Processing functions can be written in C or COBOL, with embedded SQL, to access resource managers. Presentation procedures can be C, COBOL, or vendor supplied forms systems. This modular structure provides inherent distributibility, and isolates TP applications from variations in operating system or hardware platform

STDL together with RTI provide the first functionally complete open interface for distributed transaction processing across multiple vendor platforms.

MIA Consortium

In January of 1988 Nippon Telegraph and Telephone Corporation (NTT) issued an appeal for joint research on multivendor integration.

The MIA Consortium was founded in August of 1989. MIA Version 1 specifications were published in January of 1991. Since that time MIA Versions 1.1 and 1.2 have dealt with a variety of maintenance issues and requests for clarification as various vendors proceed with their MIA implementations.

The principles of the joint research were clear. Only open technologies would be considered. Preference would be given to stable, proven international standards. Where international standards were inadequate, open *de facto* standards were selected. New technologies would only be developed where standards were not available, for example, for a TP API, a TP RTI protocol, or the IPE for integration of desktop devices. MIA Version 1 was held to a tight schedule to insure timely implementation by multiple vendors. This led to a prioritization of technical topics addressed. Extension of the technical scope of topics addressed by MIA in iterative consortium efforts is integral to the process.

NTT and NTT DATA, a subsidiary that provides software integration services to a wide variety of industries, distributed problems to the vendors in the consortium. The vendors proposed solutions. All vendor contributions to the MIA Consortium had to be open technologies. NTT and NTT data selected the best vendor proposal, and asked the vendor submitting it to drive the solution through the consortium. A consensus process assured that no solution was adopted until all vendors agreed to implement the solution.

MIA Version 1.0 Scope

Because MIA Version 1 was held to a tight schedule in order to assure timely implementation, several technical topics of interest were deferred to MIA Version 2. The underlying principle was to achieve a timely practical implementation in Version 1 that could serve as a foundation for further development in later versions of MIA.

In MIA Version 1, vendors implement proprietary security. Network management specifications are based on CMIP, and provide for fault detection for computers, programs, and communication lines, and report and status inquiry functions. MIA Version 1 only defines access to relational database management systems through SQL, though non-relational database management systems can be addressed through Departmental Computers. Forms are not portable in MIA Version 1. Many if not all of the MIA Version 1 limitations are scheduled to be addressed in SPIRIT.

SPIRIT

The Network Management Forum announced the formation of SPIRIT (Service Provider Integrated Requirements for Information Technology) in February 1993. SPIRIT brings telecommunications service providers (carriers) together to create a purchasing specification for an open standardized computing platform supporting network, service, and business management needs.

With annual computing expenditures estimated in excess of $20 billion, these large European, North American, and Asian organizations represent a significant community whose needs until now have not been uniformly defined.

SPIRIT is adopting existing technology when possible, including:

- MIA for applications
- OSCA for meta-architecture
- OSI for interoperability
- XPG.4 for documentation

SPIRIT will also select emerging technologies and develop requirements for new technologies as needed.

In May the SPIRIT Steering Committee attended a demonstration of MIA portability in Shinagawa, Japan.

MIA Portability Demonstration

NTT held a successful demonstration of portability of MIA application programs on Digital and IBM platforms in NTT's Shinagawa Laboratories on May 19-20, 1993.

Nine members of the SPIRIT Steering Committee attended the demonstration, including representatives of British Telecom, ETIS, the

Netherlands PTT, and Bellcore.

Two programs were used in the demonstration: a Subscriber Information Retrieval program and a Payment Processing program.

NTT identified the purpose of the Subscriber Information Retrieval program as "Encouraging customers in arrears to pay their bills": input data being the customer's telephone number; output data being customer information (databases: customers in arrears and customer information).

NTT identified the purpose of the Payment Processing program to be payment processing: input data being the customer's telephone number, output data being the customer's bill (databases: customer and general account).

These programs had approximately:

- 200 STDL lines of code
- 600 lines of code for processing procedures
- 700 IFDL lines of code
- 4000 Lines of code for presentation procedures

The customer-written presentation procedures implemented on the Digital system were developed using Motif to show the same look and feel as those implemented on the IBM system, which used Presentation Manager.

Source code was transferred between systems in MIA interchange formats via file transfer processes over TCP/IP.

The demonstration highlighted the following STDL features:

- Portability
- Easy switching of servers without modification of source code
- Separation of transaction and flow control from presentation and processing procedures
- Independence from human interface (presentation)

First Major MIA Project

On November 24, 1992 NTT announced award of the first major MIA project to Digital, the Listing Maintenance System (LMS). LMS maintains the customer listings for the Japanese telephone books.

The hardware configuration includes 3 VAX 10000-630s in a cluster with numerous client sites. The software for LMS includes Digital's STDL transaction processing monitor and approximately 60 other components.

Software delivery to NTT began in January of 1993. The development environment was delivered in March 1993. System delivery takes place in August 1993.

MIA Conformance

As MIA is based on standard interfaces, strict conformance criteria are required to insure portability and interoperability over multivendor platforms. MIA Version 1 conformance criteria have been defined on the level of implementation difficulty. Eight conformance classes have been defined:

- 3 classes for workstations
- 3 classes for hosts
- 2 classes for IPE (including personal computers)

Full details regarding the conformance classes can be found in *Appendix A Conformance Classes* of ***Technical Requirements: Multivendor Integration Architecture Version 1.1 Division 1: Overview*** (London, New York, and Tokyo, 1992).

Digital's Contributions to MIA

NTT chose Digital's TP monitor as the base for its multivendor specification because they wanted portable, client/serve TP applications. Digital's VAX ACMS TP monitor was the only client/server TP applications. Digital's TP monitor was the only client/server TP monitor in widespread use at the time, and contained a high-level TP language called the Task Definition Language. A high-level language such as STDL represents the only practical way to integrate widely different products utilizing existing interfaces by providing a thin layer that would fit on top of all of them.

Based on the technology in its VAX ACMS TP monitor, Digital created the STDL and RTI specifications for the MIA Consortium to solve the portability and interoperability problems for multivendor TP.

After creation by Digital and careful review by the MIA Consortium, the RTI protocol was submitted to X/Open and adopted as the basis for its TxRPC (Transactional Remote Procedure Call) protocol. The adoption of the RTI protocol by X/Open validates the approach to open systems followed by NTT.

Benefits of MIA

Good software standards describe the *interfaces* and *protocols* of software, not the implementation of the software itself. This allows creativity of implementation alternatives to realize the standard in even more effective ways while retaining the flexibility to mix and match software from multiple vendors.

The benefits of software standardization are apparent in the ability to run any application on any platform and to connect any platform to a common network. Standards identify the point of separation between an underlying platform, which can flexibly be supplied by any vendor, and the application itself.

The major mares of standardization for software are programming interfaces and network protocols. Programming standards enable application portability and network standards enable interoperability.

An application built on top of a standard application programming interface can be moved to another platform without changing the application. Platforms that support the standard network protocols can be plugged into the network interchangeably.

Benefits to Digital

MIA makes Digital an equal player in a field that has traditionally been dominated by mainframe vendors. MIA also opens up new customers to Digital.

Defining The Need

S.C. Setia
News Editor
Doordarshan
New Delhi, India

The Electronic Media, especially, Television has great relevance and significance for a developing country like India. India represents the developing world where social, economic and cultural transformation is taking place at a fast rate. Television id definitely contributing a lot to enhance this process of change. India is not only the second most populous country, ethnic and linguistic varieties. More than 40% of its population is illiterate. This makes the role of Television in India not only imperative, but also difficult and challenging. DDI which is just three and a half decades old, has developed into one of the biggest TV networks.

Introduction of new telecommunication techniques and launching of indigenous satellites has upgraded the quality of DDI programmes and enhanced its reach to the people. Now DDI's transmission is available to more than 80% of the country's population. It is one of the few T.V. organizations which use domestic satellites for telecast of National and regional services. Apart from entertaining and informing the countrymen, DDI is shouldering the social obligation of enlightening the masses.

In this context News remains one of the most positive and popular ingredients of DDI. In addition to the National news bulletins in English and Hindi telecast from Delhi, fourteen centres of DDI broadcast news bulletins in respective regional languages. Generally the news is gathered by correspondents of DDI stationed it different places. The news is fed to the Regional Centres and Delhi. Visual news or Voice Over capsules are fed through microwave links or satellite links. In some cases, regional bulletins are recorded and the relevant items are picked up from them to be used in national and other regional bulletins. However, geographical vastness and use of different languages in different States and regions pose serious problems for the news broadcasters. Due to these obstacles, display of visual content of the news gets delayed. Remoteness of the place of event and insufficient availability of communication facilities is yet another handicap. Because of such difficulties we fail to cover some big accidents and other important incidents taking place in remote areas. For coverage of some events O.B. Vans are used but their scope is very limited. This imbalanced coverage provides unwanted urban bias to the news broadcast as problems and interests or rural, hilly, desert and forest areas remain unnoticed and unserved. To correct this unjust situation, further expansion of existing technology and invention and adoption of new techniques is required. We can learn a lot from the experiences of each other country to improve the collection and distribution of Television News.

Hi-8 In The High Arctic

Abraham Tagalik
Network Program Director
Inuit Broadcasting Corporation (IBC)
Rankin Inlet, Canada

IBC, the Inuit Broadcasting Corporation, was created in response to the arrival of television into the inuit home land in the mid 70's. IBC's mandate is based on the preservation and promotion of Inuit culture. Now on our eleventh year, we provide five hours a week of inuktitut television in variety of formats for children, youth and adults. IBC currently does six programs, consisting of current affairs, cultural, entertainment, phone-in, preschoolers/children and youth. IBC has 5 production centres all submitting material for our network programs.

Producers submit story ideas for approval and they are responsible to script, shoot, edit and package their own material. A very popular format is Hi-8, the home video camera has produced some incredible results at very reasonable cost. Hi-8 has been embraced due to portability and ease of operation. Field conditions are severe to say the least, producers can keep small cameras warm inside their parkas ready for the right shot. The home video camera has bridged the gap between communities and has made our job of coverage a little easier. Recent overall improvements in the Hi-8 format has made the quality almost comparable to 3/4 and beta.

State-Of-The-Art Electronic News Gathering
"The Ultimate One-Man-Band: NY 1"

Paul Sagan
Senior Vice-President
Time Warner Cable Programming, Inc.
New York, USA

Rapid technological developments have fundamental changed the way television news is collected, produced and distributed. These changes alter the way news events can now be reported and by whom. Smaller and simpler cameras that are operated by journalists themselves allow a much broader range of individuals to become television news reporters, and allow much wider coverage of a market for less money.

In September of 1992, Time Warner Cable launched New York 1 News, a 24-hour all news channel, now available to 1.2 million subscribing households in New York City. The successful experiences of this start-up venture demonstrate a realistic and new approach to electronic news gathering, training and performance standards, and an alternative style of local news.

My remarks will focus on the in-field production methods used by NY1, not on the in-house techniques employed at the station to produce round-the-clock news programming. However, it is important to understand that the Hi-8 video journalism practiced by NY1 co-exists in a production structure devoid of a single dedicated camera operator, stage manager, control room director, associate director or production assistant, teleprompter operator, lighting director, or still store or character generator operator.

NY1's objective was a big one: to cover a city of 7 million people 24 hours a day on a limited budget. One of the ways NY1 met this objective was to create "video journalists," reporters who not only cover a story, but shoot their own video as well. This has allowed NY1 to commit fully 60% of its 115-person staff to new gathering, including 25% to in-field reporting, thus putting more journalists in a position where they often uncover stories, sometimes literally run into stories, and once in a while go where larger network crews have great difficulty.

The journalists themselves are also a different breed than at a typical broadcast television station. Because we found that the equipment is relatively simple to use, NY1 is able to recruit journalists with in-depth knowledge of the city and then reach them about television, rather than hiring people with an in-depth knowledge of television and teaching them about the city. At NY1, the station's reporters are required to have grown-up New York City, attended school there or be working in the job there. They are also required to have worked as a journalist, but not necessarily as an on-camera television reporter. No technical knowledge is required.

The first group of video journalists at NY1 went through a four-week training program in 1992 during which they learned the basics of how to operate a camera to shoot video for their own stories. Only a few had worked on-camera previously, and virtually all had no technical knowledge. Their backgrounds included working as newspaper or radio reporters. Several were field producers at New York City broadcast television stations. Within two weeks, every one was able to shoot and produce his or her own air-worthy stories from start to finish, except for video editing, which is most often, but not always, done by a trained tape editor.

The video journalists are equipped with simple field packs, each of which consists of a three-chip CCD Hi-8 camera with a top-mounted light, multiple audio options, spare batteries and a tri-pod. (A complete equipment list of a sample field kit will be distributed.) The reporters are assigned to cover specific subjects, or beats, much like print reporters. Some of the beats include politics, education, mass transit, business, health and medicine, consumer reporting, sports and entertainment.

Though many of the journalists were skeptical at first, most of NY1's reporters now find they enjoy the increased editorial control they have over their stories, and might give up their cameras no more willingly than they would give up their notepads.

Phone In Your Video

Chad Boss
Vice-President
FoNet, Inc.
Broken Arrow, USA

The FoNet™ FirstLook Video™ news gathering and flash transmission system is a revolutionary new system that uses economical leading edge technology allowing you to capture and send complete full motion pictures and sound from a remote mobile unit to an automated, unattended host receiver/player unit in the studio. The FoNet™ FirstLook Video™ system has been designed with the user in mind. It is simple to install and easy to use.

The FirstLook Video™ Remote Unit is as small as airline carry-on luggage and is as easy to install as plugging in a cigarette lighter. The unit has even been installed in a small boat where pictures from the middle of a major flood area were captured and transmitted back to the home station 500 miles away. After the simple installation, the FirstLook™ Remote Unit is ready to accept and transmit any video signal whether it is VHS, Beta, high 8MM, 8MM home movie camera, etc.

By simply clicking three buttons on the remote system, you are able to capture that important news story AND transmit it back to the station. Everything is automatic. The system manages the transfer while you are freed to go about other duties or capture other stories.

Back at the television station the automated, unattended Host Unit stands ready to receive files 24 hours a day, store the files, or be ready immediately after receiving the news clip to go out with an NTSC signal or, if you prefer, a PAL signal. The signal can go directly on the air or it can be transferred to tape for editing and later use. The Host Unit is designed so that news stories can be received at the same time an earlier video clip is being played on the air. This allows the use of multiple Remote Units with one Host Receiver/Player Unit.

The system has been recognized for its ability to get the news first, whether it is threatening weather, late breaking news, that important civic meeting, sports events or news from a remote location that is unreachable by any other means. You can be there first to beat the competition and keep you viewers up to the minute on fast breaking events with the FoNet™ FirstLook Video™ transmission system.

Not only is it an outstanding first strike news gathering tool, FirstLook Video™ uses the most economical means of transmission available in the world today ... standard analog telephone lines. For complete flexibility, you may transmit from the actual site of the breaking story using standard cellular telephone systems.

DIGITAL MMDS: A WIDE AREA SERVICE ALTERNATIVE TO SATELLITE DBS

By

W.E. (Bill) Evans, P.Eng. and K.G. (Ken) Babb, P.Eng.

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Winnipeg, Manitoba
Canada

While most proponents of satellite Direct Broadcast Service suggest that DBS technology affords the most economic means of providing multichannel television service to rural households, the use of digital video compression (DVC) coding and transmission techniques, coupled with MMDS technology, can produce surprisingly effective wide-area distribution results. In the early stages of satellite DBS implementation, the digital MMDS distribution alternative may well enjoy a significant cost advantage over the DBS alternative. This article outlines the substantial transmission and coverage advantages of digital MMDS transmission, shows how lower cost, broadband multichannel transmission technology can be used for rural service extension, and presents the estimated costs associated with a practical digital MMDS application in a large rural area of western Canada.

DIGITAL TRANSMISSION ADVANTAGES

While digital compressed video's advantage of facilitating multiple signal carriage within the same bandwidth occupied by one conventional analogue signal is widely appreciated and has profound positive implications for the broadcast industry, the dramatic performance advantages afforded by use of digital transmission techniques are less well known and appreciated in an industry that has relied upon analogue transmission to date.

The testing and viewer evaluation of various digital video compression systems undertaken over the past two years at the Advanced Television Test Centre (ATTC) in Arlington, Virginia (1), with the objective of defining a North American standard for provision of 6 MHz High Definition Television (HDTV) has greatly stimulated the development of both video compression and advanced, spectrally-efficient digital modulation schemes that can provide high quality, reliable transmission over broadcast facilities, even in deep fringe conditions replete with signal interference and fading. The ATTC tests have also determined the required carrier-to-noise ratios and both co-channel and adjacent interference protection ratios required by the various DVC systems for operation in concert with analogue signals and with each other. The results are dramatic when compared to existing analogue requirements and may be loosely summarized as follows:

- Digital RF carrier-to-noise ratios (CNR) required to deliver high quality, reliable video pictures (SNRs maintaining the video input quality at the transmitter) range as low as 11.1 dB, with 16 dB representing the general Threshold of Visibility (TOV) value. This contrasts dramatically with the 50 dB analogue signal CNR that is a modern CATV system objective.
- Co-channel interference protection requirements for digital signals interfering with each other are essentially equal to the threshold CNR value. The 16 dB protection ratio contrasts with a 45 dB minimum objective for analogue MMDS.
- Co-channel interference protection requirements for analogue interference with digital range from +2.0 dB to -8.0 dB, suggesting that the unwanted analogue signal can actually be stronger than the desired signal with two of the systems tested.
- Digital to analogue co-channel interference requires a protection ratio of about 50 dB or better, depending upon the specific digital system.

While the different test systems exhibit slightly different protection ratio characteristics, all systems tested demonstrate substantial advantages over analogue video transmission. All systems utilize Adaptive Time Delay Equalization (ATDE) to effectively compensate for multipath conditions, along with Forward Error Correction (FEC), and are targeted at supporting provision of household set-top digital decoders at prices in the $200 (US) range. General Instrument Corporation has already accepted decoder orders from US cable MSOs totalling almost 2.5 million units, to be delivered starting in 1994 at prices in the range of $200 (US) (2). The 6 MHz cable industry compression decoders will utilize QAM or VSB techniques to provide the requisite bandwidth efficiency. While the General Instrument cable television will utilize 64-QAM modulation, the Zenith vestigial side-band (VSB) technique appears to afford advantages for terrestrial transmission (3). A "bake-off" between QAM and VSB is being held in early 1994 in an attempt to ascertain the strength and weaknesses of both modulation systems. The Zenith VSB modems will support dynamic selection of various levels of VSB modulation — 2 VSB, 4 VSB, 8 VSB or 16 VSB without any hardware changes (4).

BROADBAND MULTICHANNEL TRANSMISSION

A fundamental support element for the proposed digital MMDS system is the ability to utilize **broadband multichannel** transmitters, repeaters and translators for all signal transmission applications — both "broadcast" and trunking. The universal use of broadband technology, with its attendant substantial cost benefits, is made singularly possible by digital transmission. Conventional, analogue wide-area service MMDS facilities require individual channel output powers of between 10 and 100 Watts to meet service objectives of a 45 dB CNR under line-of-sight conditions with modest margins (7 dB) for grazing losses. Channelized transmitting facilities of this type entail substantial capital costs when compared to low power, broadband configurations. Broadband multichannel configurations can entail costs that are less than 20% of those for channelized 50 Watt facilitaties of 10 to 15 channel capacity.

Broadband MMDS transmitting configurations with single carrier output power ratings of 50, 70 and 100 Watts are available from a number of manufacturers. Given that manufacturers tend to specify power amplifier output ratings using various different criteria, in analogue MMDS the Third Order Intercept Point (IP_3) is the principal design consideration, while for digital system design the required specification is the single carrier output power at the 1 dB Compression Point.

The coverage comparisons for broadband facilities between analogue and digital implementations reveal the digital advantage dramatically. For a 70 Watt amplifier rating, the analogue omni-directional coverage with 12 channel loading at a composite triple beat ratio of -56 dBc is 6.0 km, while the digital implementation can produce a 10 RF channel coverage range of 71.2 km, assuming a tower height of 470 m (5). A large measure of the increased digital coverage stems from the ability to obtain a higher individual carrier digital power level out of the transmitter (1.8 Watts) versus the analogue application (0.44 Watts) which must be derated substantially because of the triple beat distortion ratio requirement. The digital output power is established by allowing a 6 dB backoff from the 1 dB compression point to compensate for transient and peak power excursions, as determined by the ATTC testing program (6)(7).

The average digital output powers and coverage ranges supported by broadband transmission facilities of various power ratings are as shown in Table 1. The ranges presented assume use of sufficient transmitting antenna height to produce an unobstructed radio path to the reception location with a propagation availability of 99.9%, and the use of the following transmission parameters:

- Receiving antenna gain of 24 dBi and a block downconverter (BDC) noise figure of 3.5 dB.
- Mid-continent climatic and prairie terrain conditions.
- Minimum threshold (TOV) CNR of 16 dB, assuming use of 4 VSB modulation.
- Coverage range established within the radio horizon at a CNR of 36 dB (20 dB margin over TOV).
- Omni-directional transmitting antenna with 15 dBi vertical pattern gain.
- Tower-mounted transmitting equipment directly connected to the antenna.

Existing analogue MMDS transmitting facilities may be able to handle digital modulation formats well, subject to de-rating output power and provided that the phase noise and group delay characteristics of the existing configuration are acceptable.

TABLE 1: Ten Channel Digital MMDS Power - Range Capabilities

Broadband Power Rating		Output Power per RF Channel		TX Antenna Gain (Omni)	Operating EIRP	Coverage Range
(Watts)	(dBm)	(Watts)	(dBm)	(dBi)	(dBW)	(km)
100.0	50.0	2.5	34.0	15	19.0	76.3
70.0	48.5	1.8	32.5	15	17.5	71.2
2.0	33.0	0.1	17.0	15	2.0	20.0
0.02	13.0	0.0005	-3.0	11	-22.0	5.0

The coverage ranges in Table 1 are all within the radio horizon "seen" by the assumed transmitting antenna locations. While the protected service limit of analogue MMDS facilities is generally within the optical horizon, the authors believe that the superlative characteristics of the digital format will support coverage extension to the radio horizon.

In most cases the digital MMDS signal package would be received off-air and repeated in adjacent cells using broadband translators. In some cases, point-to-point trunking links (arrows in Figure 1) may be required to deliver the signal package to a more distant cell transmitting site. Such trunking links would utilize a 2 Watt broadband UPA and high gain parabolic receive and transmit antennas.

While digital signals can be repeated and/or translated with much less signal degradation than is the case with analogue transmission, should lengthy multi-hop configurations be required, digital regeneration could be employed to reconstitute the digital bit stream at appropriate locations.

A PROPOSED CELLULAR IMPLEMENTATION

To provide almost ubiquitous urban and rural area signal coverage over wide areas, a cellular transmission scheme is required, with coverage patterns from adjacent transmitting sites overlapping each other to a significant degree. While cellular telephone service normally requires the use of at least three sets of frequencies, the ability to use orthogonal polarization and high gain, directive antennas with MMDS technology supports cellular system creation with just two frequency groups.

Figure 1 presents the coverage patterns projected for a digital, cellular MMDS system (called MDS in Canada) established using existing broadcaster and common carrier towers in the southern portion of the Canadian province of Manitoba. The twenty cells shown provide coverage of an area of 163,000 square km — slightly larger than the states of Illinois, Georgia or Michigan. The use of two frequency groups, each containing ten 6 MHz RF channels in the frequency range from 2.566 to 2.686 GHz is assumed, providing between 40 and 100 channels of video program delivery, depending upon the compression ratio and/or modulation system used. Use of 16 VSB techniques will support up to 23 motion picture films being transported in a single 6 MHz channel, as demonstrated by Zenith Electronics. However, 16 VSB requires a TOV of about 28 dB when FEC is employed, versus 20 dB for 8 VSB and 16 dB for 4 VSB.

The total capital cost of the proposed transmission facility is estimated at $2.6M, including installation, engineering, licensure, civil works, standby power supplies, status monitoring, telemetry and one hundred percent standby spare capability at all locations. The estimated number of households in the combined service area that are not presently passed by cable television facilities is estimated at 60,000. Using a projected subscription penetration rate of 50 percent, the per-subscriber capital cost allocation for the digital transmission system is just $86. Given that the subscriber potential does not include any homes in cities or towns, all of which are served by cable television, and that the rural population density is comparatively low in Manitoba, it appears reasonable to assume that lower per household transmission costs would be obtained in many other geographic locations, particularly if towns and/or urban households are included.

Households receiving the digital MDS signal directly would require a receiving antenna, BDC, cabling and a cable television DVC decoder representing a total equipment cost of about $300 (US), assuming use of the $200 cable industry 6 MHz decoder terminal. Adding the capital cost allocation for the digital MDS delivery system would produce a total capital cost of about $390 — well below the $700 (US) capital cost to a homeowner being suggested initially for a Hughes DirecTV DBS package (8).

Capital costs for conditional access control equipment, billing and origination centre QPSK to QAM/VSB conversion equipment are not included in the transmission system costs. Given the comparatively heavy costs of digital compression equipment, it is obvious that availability of compressed signals via satellite is a major supporting element to use of digital MDS in rural areas.

The Manitoba digital MMDS implementation assumes the use of a centralized **origination centre** for the digital service, shown in Figure 2, providing the following functions:

- TVRO reception of desired satellite signals;
- Transcoding from the satellite QPSK format to QAM/VSB for MMDS distribution;
- Compression and insertion of regional programming signals, including educational television;
- Standards conversion for various DVS formats;
- Conditional access control and billing system functions.

While the cost advantage enjoyed by the digital MMDS implementation, versus satellite DBS, might only exist for several years, it is not likely that the DBS reception costs would drop below those for digital MMDS. The abilities of a digital MMDS infrastructure to support distribution of regional programming — news, sports, special events and educational — is an important advantage over DBS in many countries internationally. Assuming long-term cost competitiveness with DBS reception equipment, the digital MMDS alternative described could find significant acceptance in many parts of the globe as an alternative to both more costly cable television in urban areas as an alternative to DBS, offering more localized programming, in rural areas.

The ability to implement the digital MMDS infrastructure described depends upon the regulatory circumstances and present band occupancy in the country of interest. In Canada, the 20 channel requirement is available virtually everywhere, while in the United States it would be more difficult to evolve present MMDS and ITFS operations to digital, thereby broadening the opportunity to extend out into rural areas with networks of repeaters and translators. Overseas there would seem to be much potential for digital MMDS implementation.

TELECOMMUNICATIONS APPLICATIONS

The dramatic development of highly spectrally-efficient modems for DVC use with both HDTV and standard (NTSC, PAL) television has significant potential for wireless telecommunications. The 16-VSB modem which is capable of transporting 43 Mbit/s in 6 MHz of spectrum, and which includes an adaptive time delay equalizer for multipath cancellation is a manifestation of the dramatically enhanced potential for high speed wireless data transmission.

Subject to spectrum availability, wireless metropolitan area networks (MAN) capable of providing two-way videoconferencing and high speed voice/data transmission would seem possible in the foreseeable future, using asynchronous transfer mode (ATM) as a network protocol in various frequency bands that may be available. With allocations equivalent to the MCS or MDS bands in Canada (2.500 to 2.686 GHz), regional (urban and rural) networks employing ATM topology could be implemented. Currently, cable television industry interest in ATM transport is stimulating development of ATM switches for multiple DS-3 rate cable television applications. This technology should be capable of migration to wireless configurations.

INTERNATIONAL MARKETS

The ability to implement the digital MDS infrastructure and/or any telecommunications applications described depends upon the regulatory circumstances and present band occupancy in the country of interest. Digital MDS television system implementations will depend as well on the availability of satellite-delivered television signals in a DVC format.

The move to digital compression of a significant number of satellite television signals is by no means confined to North America. Satellite DVC signals already exist in Central and South American and are scheduled to be expanded in capacity. Major DVC offerings have been recently announced for satellite delivery to countries in the Middle East. In Asia, Hong Kong-based Star TV plans to offer a package of DVC program signals and the proposed Australian DBS service will almost certainly utilize DVC.

Both the multichannel television and telecommunications applications of digital MDS technology should be of considerable interest in emerging nations where there is little likelihood of economic viability for establishment of cable television system using coaxial and/or fibre optics cables and where the urban and rural telecommunications infrastructure has significant limitations in its ability to transport high speed integrated video, voice and data services.

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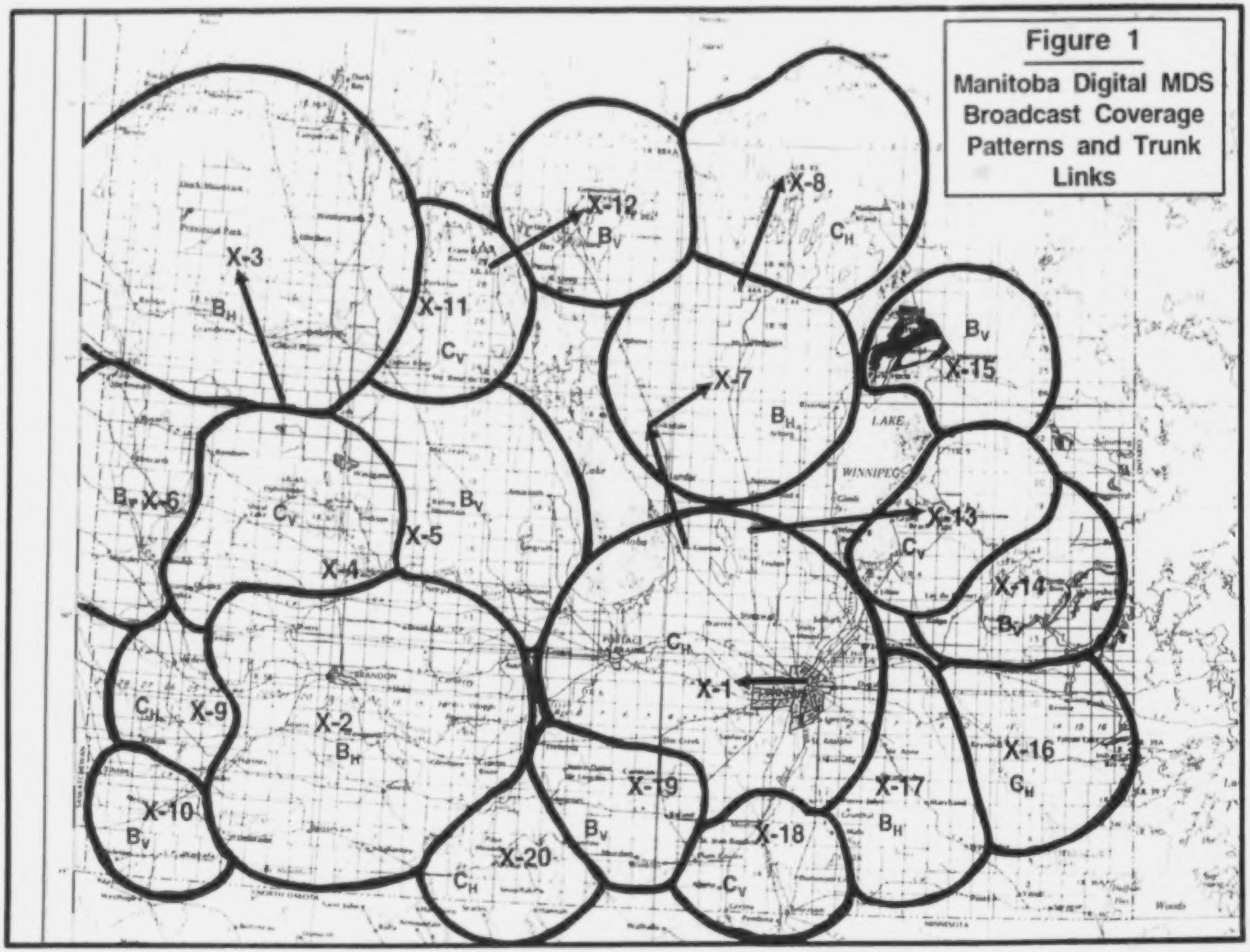
X-1
C_H
X-2
B_H
X-3
B_H
X-4
C_V
X-5
B_V
B_V X-6
X-7
B_H
X-8
C_H
C_H X-9
X-10
B_V
X-11
C_V
X-12
B_V
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C_V
X-14
B_V
X-15
B_V
X-16
G_H
X-17
B_H
X-18
C_V
X-19
B_V
X-20
C_H
LAKE
WINNIPEG
BRANDON
PORTAGE

Figure 1

Manitoba Digital MDS Broadcast Coverage Patterns and Trunk Links

BEST COPY AVAILABLE

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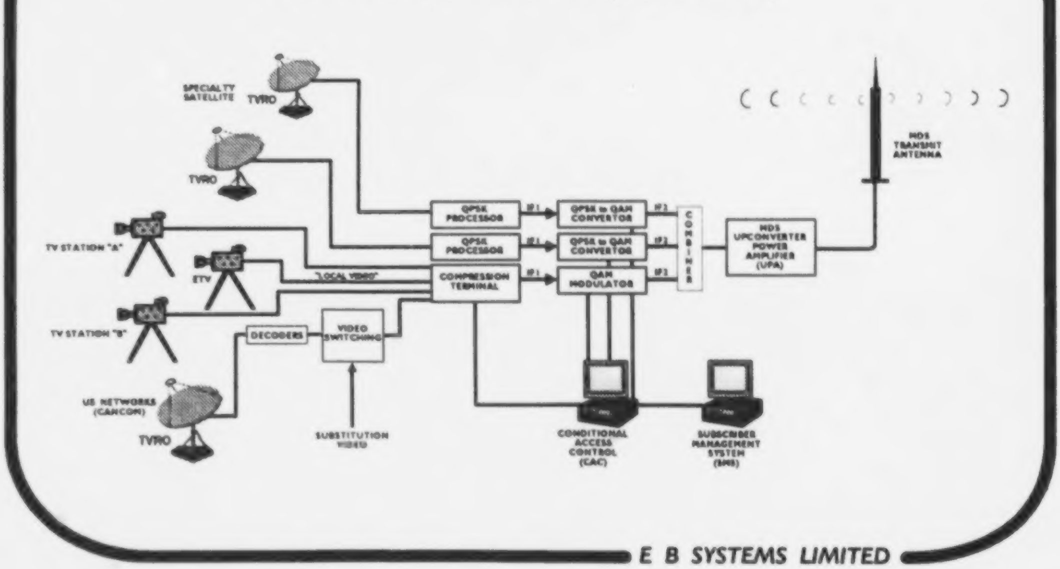
FIGURE 2
ORIGINATION CENTRE (REGIONAL)


SPECIALTY SATELLITE
TVRO
TVRO
TV STATION "A"
ETV
TV STATION "B"
US NETWORKS (CANCOM)
TVRO
"LOCAL VIDEO"
DECODERS
VIDEO SWITCHING
SUBSTITUTION VIDEO
QPSK PROCESSOR
QPSK PROCESSOR
COMPRESSION TERMINAL
IF1
IF1
IF1
QPSK to QAM CONVERTOR
QPSK to QAM CONVERTOR
QAM MODULATOR
IF2
IF2
IF2
COMBINER
MDS UPCONVERTER POWER AMPLIFIER (UPA)
MDS TRANSMIT ANTENNA
CONDITIONAL ACCESS CONTROL (CAC)
SUBSCRIBER MANAGEMENT SYSTEM (SMS)
E B SYSTEMS LIMITED

THE NETWORK OPTICALIZATION PLAN IN TAIWAN R.O.C.

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ABSTRACT

This paper will mainly describe the construction target and strategies of Optical Fiber Communication System(OFCS) networks in Taiwan, R.O.C. and also outline current status and future plans. The DGT has installed OFCS for commercial use on long distance trunk since 1983. At year end 1992, the opticalization of toll, interoffice, international trunks and subscriber loop are 85%, 61%, 71% and 0.02% respectively. DGT expects to achieve the goal of full opticalization for the above networks in years 1997, 2000, 1999 and 2020 respectively.

1. INTRODUCTION

Optical fiber has the advantages of low loss, wide bandwidth, immunity from interference, small diameter and light weight. Moreover, light source and detector components have high bit rate modulation, output power, sensitivity and efficiency. These allow repeater span to extend to a distance of several tens of kilometers. In comparison to metallic cable systems, this does not only decrease the cost, increase reliability, simplify installation and maintenance, but can make the use of wide bandwidth transmission a reality.

The Directorate General of Telecommunications (DGT), with the aim of increasing the quality of communications, increasing the reliability of network, meeting international developments in communication systems, is therefore engaged in introducing high technology OFCS in its networks. It has installed OFCS for commercial use on Long Distance trunk since 1983. It has also planned to introduce OFCS application gradually and timely to interoffice trunks, international submarine cable and subscriber loops. Moreover, DGT has regulated that all new trunks to be installed should be all OFCS since then. At the year end of 1992, the opticalization of toll, interoffice, and international trunks are 85%, 61% and 71% respectively. DGT expects to achieve the goal of full opticalization for the above trunks in years 1997, 2000 and 1999 respectively. As for the subscriber loop, DGT will accelerate the pace to meet the demand of information and video service, and expect its full opticalization by 2020.

2. TARGET AND STRATEGIES OF LONG DISTANCE OPTICAL FIBER COMMUNICATIONS SYSTEM

2.1 Construction target and strategies

The opticalization target for the long distance transmission on a yearly basis is in table 1 below. The full opticalization will expect to achieve in 1997. The strategies for construction will be as follows:

(1) All new construction of transmission systems will be in the form of optical cable.

(2) Those coaxial cable systems having substandard reliability, experiencing frequent faults and high maintenance costs will gradually fall into complete disuse by 1995.

(3) Cable systems using PCM, which are suffering from low quality, unsuited to wide bandwidth selection and difficult to maintain, will therefore not be constructed and be used only up to the end of 1996.

(4) In order to increase reliability, toll trunk lines above Toll Centers are installed as multiple routes, and moreover a round Taiwan optical fiber system will be constructed, while trunk lines below Toll

Centers serving metropolitan area as a single unit will be constructed as a ring optical fiber system.

(5) Optimization of the 405Mb/s system and expansion of 1.7Gb/s systems can aid construction of the second transmission tandem office and raise overall reliability.

(6) Technology development requirements will be met so as to suitably employ SONET related facilities, and increase operation administration and maintenance (OA&M) capabilities.

2.2 Current Status

After providing long distance optical fiber systems for the commercial service for the first time at the end of 1983, the DGT only used fiber optics when laying long distance cables, thereby steadily replacing the existing PCM systems attached to the conventional copper cables.

Over a number of years, the multimode optical fiber cables have been replaced by single mode with 6 individual fiber cores gradually expanding to a total of 96. While Optical Line Terminal Equipment (OLTE) have kept in line with technology developments, starting from the earlier 90Mb/s system (with 2DS3 each pair equivalent to 1,344 telephone channels) to 417Mb/s(9DS3, 6,048 telephone channels), and 565Mb/s(12DS3, 8,064 telephone channels). The current OLTE capacity is 1.7Gb/s (36DS3, 24,192 telephone channels).

Up to the end of 1992, about 98,372 core-km of the long distance optical fiber cable had already been laid. For further information on the systems, refer to Figure 1 and the following descriptions.

(1) Western first Optical Fiber Communications System: This system was ready for service in July, 1989, connecting Taipei with Kaohsiung, a total distance of 434 kilometers, and is of a 24 single mode fiber cable. While the capacity of OLTE is 9DS3.

(2) Eastern first Optical Fiber Communications System: The system from Taipei to Taitung was completed at the end of 1990, with the section from Su Au to Hualian following the Northern railway route. The entire operation uses 24 single mode fiber cable. The capacity of OLTE is 12DS3, operating at 1550nm.

(3) Western Second Optical Fiber Communications System: This system was along Chung Shan Freeway from Taipei to Kaohsiung was completed in August, 1992, and it uses a 48 single mode fiber cable. The capacity of OLTE is 36DS3, operating at 1550nm.

(4) The Southern Round Island Railway OFCS The system is following Kao-Ping and the Nan-Hui railway lines linking Kaohsiung and Taitung. This was completed in June, 1992, that facilitates in the round-Taiwan communications linking the existing trunk lines between Taipei-Taitung and Taipei-Kaohsiung.

(5) Taiwan-Penghu Optical Fiber Submarine Cable System (TP-1 OFSCS): This system was completed and ready for service in August, 1988, and extended from Tainan to Penghu using an 8 single mode fiber cable, and having a distance of 104 kilometers, with 87 kilometers being submarine cable (no repeater in the sea). The OLTE has a capacity of 417Mb/s (9DS3) for each fiber pair.

(6) Penghu-Kinmen Optical Fiber Submarine Cable System (PK-1 OFSCS): This system was completed and ready for service in June, 1991, and extended from Penghu to Kinmen using a 12 single mode fiber cable and having a distance of 170 kilometers. Within the underwater section between the eastern islands and Kinmen about 155 kilometers there are no repeaters in the sea. The OLTE uses 140Mb/s and its capacity is 3DS3.

(7) Taiwan-Matsu Optical Fiber Submarine Cable System (TM-1 OFSCS): This system was completed and ready for service in October, 1992, and extends from Taiwan to Nangan, Nangan to Beigan, Dongin and Xiju using a 12 single mode fiber cable having a total distance of 300 kilometers. The section from Taiwan to Nangan is approximately 185 kilometers in length with no repeater in the sea. The OLTE has a capacity of 140Mb/s.

2.3 Future Construction Plan

In the coming years, DGT plans to continue in the direction of multi-route construction, in order to promote network reliability, whenever the need arises in its long distance optical fiber communications system.

As for installation of long distance branch circuits, the schedule will conform to the existing construction progress, such as conduit arrangements, laying of cables, etc., to continue the completion of an optical fiber ring network.

Amongst these projects the most important are as below:

(1) Eastern second Optical Fiber Communications System: The system is following the Bin Hai, Suhua freeways and 11 intercounty highways from Taipei to Taitung. The section from Taipei to Hualien is scheduled for completion at the end of 1994, while the section from Hualian to Taitung at the end of 1998.

(2) Western third Optical Fiber Communications System: The system is following the Sansheng highway and the Xibin freeway, and is scheduled for completion in 1997.

(3) Western fourth Optical Fiber Communications System: The system is following the second major freeway and will be constructed conforming to the pace of freeway construction scheduled for completion in 1999.

(4) Western fifth Optical Fiber Communications System: The system is following the high speed railway and is scheduled for completion in 2001.

The construction plan and investment of long distance optical cable are as tables 2 & 3.

3. TARGET AND STRATEGIES OF INTERNATIONAL OPTICAL FIBER COMMUNICATIONS SYSTEM

3.1 Construction Target and Strategies

The aim shall be to fulfill business demand and implement a multi functional communication network, continue with investment in international submarine cables, and moreover, to be positively cooperative with international endeavors in replacing the outmoded existing analog submarine networks. Additionally, DGT expects to complete the full opticalization by the year 1999. The rate of opticalization is projected in table 4.

Prior to replacement of existing analog coaxial cables with optical systems, the following methods will be employed: (1) Several analog/digital converters will be installed so as to convert signals from international coaxial cables. (2) Maintain a multi-route system so as to facilitate the interaction between optical and coaxial systems.

3.2 Current Status

Up to the end of 1992, Taiwan had a total of 17 international coaxial submarine cable systems with a combined 3,280 channels and 14 optical fiber systems, with a total of 10,343 channels, representing a 76% opticalization rate. Investment and completion dates for the 6 major coaxial cables and 14 optical fiber cables are represented in table 5.

3.3 Future Construction Plan

In order to extend and connect Taiwan optical fiber submarine network with worldwide intelligent network and quickly bring Taiwan into possessing international standard quality communication systems, the DGT is planning to invest on a large scale. For information refer to the table 6 below. The proposed investment DGT shared for laying of the above submarine cables will be in accordance with the information in table 7.

4. TARGET AND STRATEGIES OF INTEROFFICE OPTICAL FIBER COMMUNICATIONS SYSTEM

4.1 Construction Target and Strategies

Network opticalization has already been the DGT's target, and recently in order to meet requirements for establishing Taiwan as regional financial and technology center, there has been demand for a high quality communication network. High volume interoffice trunks are therefore urgently needed. In the future the DGT is working toward meeting these requirements and has projected full opticalization in the year 2000. The target is outlined in table 8.

Recently, in order that the interoffice trunk meet the pace of construction for digital switching, and replace copper based cables, there has been a yearly increase of optical fiber interoffice trunks. The strategies for construction will be as follows:

(1) New interoffice trunks will only use optical fiber.

(2) Adopt the sub-conduit technology in order to increase conduit line efficiency rates.

(3) In order to increase reliability and safety of the network, multi-route will be adopted.

(4) In order to strengthen network OA&M requirements, the SONET will be employed in time.

4.2 Current Status

The optical fiber interoffice trunks systems has been introduced since 1985. In order to help development of the domestic optical fiber manufacturing industries, the DGT began to increasingly use optical fiber interoffice trunks in 1989. While in recent years in order to fulfill circuit requirements, and upgrade the quality of transmission network,there has been an increase in the yearly construction of these facilities. The capacity of OLTE now are ranging from 9, 12, 24 to 36DS3. Up to the end of 1992, 76,219 core-km of fiber cable had been laid, and representing a 61% opticalization rate.

4.3 Future Construction Plan

The construction of metropolitan interoffice trunk will be undertaken by DGT in accordance with market demand, with the pace of construction to increase on an annual basis, with completion of opticalization by the year 2000. The construction plan and investment of optical fiber interoffice trunk are shown in table 9 & 10.

5. TARGET AND STRATEGIES OF SUBSCRIBER LOOP OPTICAL FIBER COMMUNICATIONS SYSTEM

5.1 Construction Target and Strategies

Optical fiber cable allows completely new and far reaching developments, and should therefore be used for subscriber loop systems. Hence, in accordance with market needs, the DGT is increasing construction on a yearly basis, with the full opticalization by the year 2020. For information refer to table 11.

In recent years, the DGT has sought to fulfill the needs of the large stockbrokerage industry, the high speed financial bank data links, and the as yet to be legalized cable television operators with digital circuits. At the same time, all new high rise buildings replacement of existing systems and the difficulty associated with expanding present cable conduits will all be using optical fiber cable. The DGT will expand the optical fiber subscriber loop in accordance with the following strategies.

(1) Fiber To The Building (FTTB)

The first objective will be commercial, technological high rise, financial institutions and cable television operators. Cables as well as OLTE will be installed within the buildings. In large metropolitan areas, should there be an urgent need, the "Fiber To The Curb" method can be employed, with feeder cable being fitted to cabinet, thereby offering high speed, large volume services to customers.

(2) Fiber To The Home (FTTH)

After construction of feeder cables and in accordance with customer demands, distribution cables will be fitted to customer residences.

(3) Subscriber loops should be installed with utmost safety, reliability and management in mind. Therefore construction must be in tandem with progress in SONET, Digital Cross-connect System(DCS) and related technologies.

5.2 Current Status

The fiber cables will be introduced to meet developments in technology and satisfy customer demand. Construction has been in operation since 1991, with a 48-core feeder fiber cable construction being employed which will eventually be scaled up to using a 600-core fiber cable. Smaller distribution cable will feed to high rise buildings. The customer will provide room for installing terminal facilities and DLC's at no cost. By the end of 1992 it is estimated a total of 9,964 core-kms will be in operation.

5.3 Future Construction Plan

Construction of subscriber loop will be in accordance with demand and will use 600 core feeder fiber cables, with a yearly increase in construction. Opticalization will be in the year 2020. The investment and construction of subscriber loop optical fiber cable will be as tables 12 & 13.

6. CONCLUSION

Optical communications is the mainstream of future communications with present trends being principally in WDM, SONET, EDFA, Coherent Optical Communications, Optical Switch, FTTH and related technologes. This necessitates DGT taking notice of these developments and keeping pace with these state-of-the-art technologies, thereby making the complete long term communication goal of full optical opticalization.

The DGT, in accordance with the Six-Year National Development Plan, with an aim to raise the capabilities of present networks and provide new services, is planning an investment of NT$360 billion during the period 1991-96. As it is, the telecommunications development is no less important than the economic achievements. DGT will do its best to fulfil the government strategic goal of becoming an Asian-Pacific regional financial center as well as an international cargo transport hub, of which an advanced and efficient telecommunications service is a prerequisite. And now DGT is ready for anything to realize this aim.

Table 1 Opticalization Rate of Long Distance Cable System

Year	1992	1993	1994	1995	1996	1997
Opticalization Rate (%)	85	88.2	91.8	97.4	98.9	100

Table 2 Construction Plan of Long Distance OFCS

Item / Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
Yearly Optical Fiber(core-km)	16,628	16,000	16,000	20,000	18,000	44,000	26,000	32,000	26,000
Total Optical Fiber(core-km)	115,000	129,000	145,000	165,000	183,000	227,000	253,000	285,000	311,000
Yearly OLTE(set)	85	60	60	150	112	130	100	135	115

Table 3 Investment Capital
Unit:NT $1 million

Item / Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
Conduit	365	390	290	485	1,135	1,410	885	925	580
Optical cable	910	325	425	480	860	1,020	610	920	930
OLTE	260	180	180	1,050	750	860	660	1,020	1,220
Total	1,535	895	895	2,015	2,745	3,290	2,155	2,865	2,730

Table 4 Opticalization Rate of International Submarine Cables

year	1991	1992	1993	1994	1995	1996	1997	1998	1999
opticalization rate (%)	74	76	88	89	92	93	95	98	100

Table 5 Existing International Submarine Cable System

System Type	Cable Name	Completion Date	channels
Analog coaxial submarine cable	1. OKITAI	1979.7.9	468
	2. TAILU	1980.3.28	484
	3. TAIGU	1981.5.13	630
	4. S-H-T		
	H-T	1985.10.10	460
	H-S	1986.8.1	106
	5. A-I-S		
	A-I	1986.8.11	30
	I-S	1986.5.1	46
	6. SEA-ME-WE	1986.6.18	202
Digital optical fiber submarine cable	1. HAW4	1989.3	740
	2. TPC3		
	H-G	1989.3	789
	G-J	1989.3	270
	3. G-P-T		
	T-P	1989.12.21	1,640
	T-G	1989.12.21	3,720
	4. H-J-K	1990.5	30
	5. HONTAI-2	1990.8.6	1,530
	6. NPC	1991.5.15	300
	7. K-K	1990.12	90
	8. MAT-2	1991.9	20
	9. B-M-P	1992.2.28	252
	10. B-S	1992.2.28	120
	11. AN-2	1992.3	60
	12. TAT-9	1992.3	62
	13. TAT-10	1992.8	90
	14. TPC-4	1992.11	630

Table 6 Planning of International Optical Fiber Submarine Cable Systems

Cable Name	Completion Date	Channels
1. APC	1993.7.31	7,200
2. PACRIM-E	1993.5.15	30
3. PACRIM-W	1995.2.15	120
4. HAW 5	1993.3.15	30
5. SEA-ME-WE2	1994.6	300
6. TAT-11	1993.8	60
7. TPC-5	1995/96	2,190
8. M-T	1993.9	60
9. TAT 12/13	1995/96	240
10. COLUMB-2	1996	210
11. AMERICA	1996	60
12. RIOJA	1995	180
13. RJK	1995/6	60

Table 7 Investment Capital Unit: NT$1 million

Year	1993	1994	1995	1996	1997
Budget	1,040	865	586	392	344

Table 8 Opticalization Rate of Interoffice Cable System

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000
Opticalization Rate(%)	61	68	75	80	85	90	95	98	100

Table 9 Construction Plan of Interoffice OFCS

Item \ Year	1993	1994	1995	1996	1997	1998	1999	2000
Total Optical Cable(core-km)	80,480	103,347	123,767	143,537	163,267	182,500	210,500	219,500
Total Terminal Equipment(DS3)	28,682	32,423	36,134	39,764	43,305	46,700	50,000	53,200

Table 10 Investment Capital Unit: NT$1 million

Item \ Year	1993	1994	1995	1996	1997	1998	1999	2000
Optical Cable	765	882	837	820	785	769	760	720
Transmission Equipment	1,941	1,389	1,362	1,322	1,282	1,188	1,155	1,120

Table 11 Opticalization Rate of Subecriber Loop

Year	1992-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016-2020
Opticalization Rate(%)	0.3	12	30	50	75	100

Table 12 Construction Plan of Subecriber Loop

Item \ Year	1993-1995	1996-1998	1999-2000	2001-2005	2006-2010	2011-2015	2016-2020
Total Optical Cable (Core-km)	42,078	88,000	133,000	308,000	448,000	808,000	1,058,000
Total Terminal Equipment (DS3)	907	2,200	3,800	9,800	15,800	23,300	30,800

Table 13 Investment Capital Unit: NT$1 million

Item \ Year	1993-1995	1996-1998	1999-2000	2001-2005	2006-2010	2011-2015	2016-2020
Optical Cable	1,028	1,200	1,170	4,376	6,250	7,500	7,500
Transmission Equipment	1,326	1,962	2,400	8,400	8,400	9,750	9,750

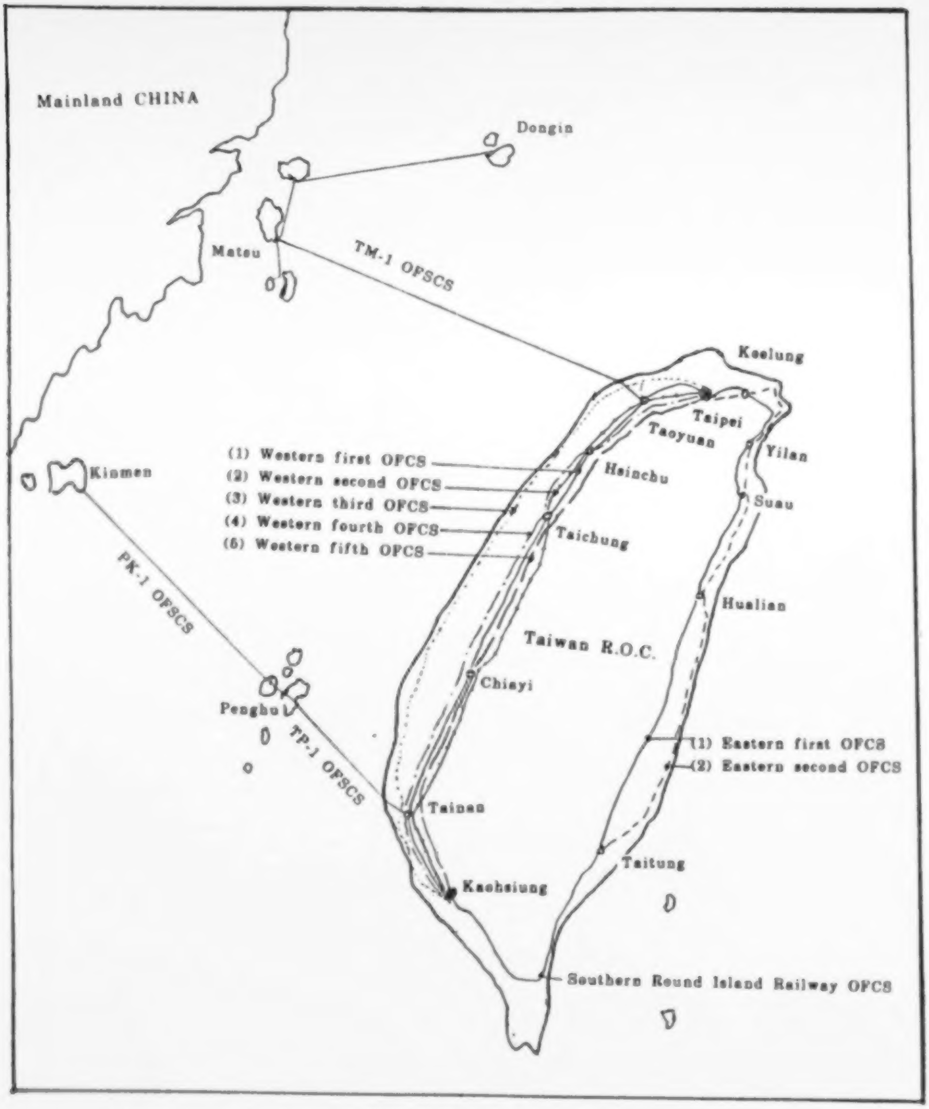
Mainland CHINA
Dongin
Matsu
TM-1 OFSCS
Keelung
Taipei
Taoyuan
Yilan
Kinmen
(1) Western first OFCS
(2) Western second OFCS
(3) Western third OFCS
(4) Western fourth OFCS
(5) Western fifth OFCS
Hsinchu
Suau
Taichung
Hualian
PK-1 OFSCS
Taiwan R.O.C.
Chiayi
Penghu
TP-1 OFSCS
(1) Eastern first OFCS
(2) Eastern second OFCS
Tainan
Taitung
Kaohsiung
Southern Round Island Railway OFCS

Figure 1 Major Long Distance Optical Fiber Communication Systems

CONTRIBUTION BY THE OPERATORS OF PRIVATE TELECOMMUNICATION SERVICES TOWARDS DEVELOPMENT OF TELECOMMUNICATION INFRASTRUCTURE OF SRI LANKA IN THE RECENT PAST

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1. ABSTRACT

Within the past two years with the reforms of the telecommunication infrastructure in Sri Lanka several private companies have commenced special services such as cellular services, data communication services, facsimile services, trunk networks, pay phone services etc investing capital funds via joint ventures with foreign collaborators etc. Most of these special services and associated infrastructure have supported the overall telecommunication infrastructure development, and competitive service environments have been created. The article highlights the development and the future directions of the involvement by these private operators and its impact on the overall penetration of telecom services.

2. SRI LANKA AND ITS DEVELOPMENT OF TELECOM INFRASTRUCTURE BEFORE 1991

Sri Lanka is an island nation with a population of 16.9 million concentrated into 65,607 sq. km. It is relatively poor, with a per capita GNP of US$ 498 in 1992. A former British colony, Sri Lanka has been independent since 1948. Its economic policies may be periodized as traditional plantation based policies (1948 - 1956), import substitution industrialization policies (1956 - 1977) and export oriented open economy policies (1977 to the present). Sri Lanka generally scores high on Physical Quality of Life (PQLI) type indexes because of relatively well developed educational and health systems. Literacy levels are high for a third world country and population growth rates are low (1.3% in 1989). Sri Lanka has a tradition of civilian led, democratic governance, with multiple political parties and more or less regular elections. Sri Lanka has a recorded telecommunications history as far back as to year 1858. Telephone lines per 100 inhabitants may be around 0.71 which is slightly above the South Asian average of 0.68.

At the early stages of development towards 1966, 23 strowger exchanges were installed in metropolitan Colombo areas for introduction of subscriber trunk dialing. The Outer Colombo Area Development Project 1 (OCADS 1) was completed in 1973, equipping major cities outside the capital area with cross bar switches and establishing microwave and cable inter exchange links. In 1976 Sri Lanka was linked to foreign countries via INTELSAT and first international gateway was commissioned providing a limited capability for international direct dialing. In 1980 little over 60,000 direct exchange lines were in operation with total number of telephones over 80,000. Exchange capacity at this time was approximately 93,000 lines and there were no digital exchanges. After 1977 normal growth of demand had been accelerated by the open economic policies of the government and high usage of available telephone lines contributed to difficulties in completing calls. Towards early '80s digital exchanges of the types E10 (CIT Alcatel) and NEAX (Japanese) were introduced to the telecom infrastructure and the Colombo metropolitan areas were getting updated with these new Exchanges. As at today 85% of the total telephones (approximately 150,000) are served by digital exchanges and almost island wide subscriber trunk dialing facilities are available. With regard to transmission systems 85% are based on terrestrial microwave links and PCM systems which couple four E10 exchanges, ten NEAX exchanges and five DX200 (Nokia) providing the island wide network. The country has a telex service with over 1,500 telexes, faxes and a limited amount of data communications links.

3. REFORM PROCESS

The restructuring of the Sri Lankan telecommunication industry began in 1980 with the separation of the Department of Telecommunications from the Post Office. Both institutions continued to report to the Minister of Posts and Telecommunications. The Department of Telecommunications functioned as a normal government department, subjected to limitations on the ability to hire, fire and discipline employees, to raise funds independently, and retain earnings for internal use. The separation was actively encouraged by the World Bank which agreed to provide financial assistance by way of loans for development of telecommunication services.

After 1980 very many improvements to the telecom services came into effect and Sri Lanka was one of the few Asian countries which acquired digital exchanges very early to serve the metropolitan communities. With the open economic policies of the past 1977 period the normal growth of demand accelerated, even though the high usage of available telephone lines contributed to difficulties in completing calls. The obsolete cable network appeared to be the primary cause of the reliability problems. Towards 1985 the exchange fill (percentage of exchange capacity utilized) was 64% (compared to 66% in 1980) and ratio of employees to 1,000 Direct Exchange Lines (DEL) was around 114 (compared to 166 in 1980). These common indicators of the efficiency showed the inefficiency of the telecommunications administration.

After mid 1970s heavy demands were made of international telecommunication services by the movement of temporary workers to the Middle East. Given the extremely limited facilities for international telephony then available from the Department of Telecommunications some entrepreneurs established telecommunication bureaus. These were essentially resellers of telecommunication services such as International Direct Dialing (IDD) services, telex services, and by the mid 1980s fax services. The Department did not initiate the bureaus, but provided the necessary facilities recognizing their utility. The bureaus were not limited to international services, providing local and domestic long distance services as well, sometimes in conjunction with postal services and photocopying services. They also offered incoming telex and fax message services whereby customers would be notified of incoming messages for a small fee.

In 1984 a Presidential Committee was appointed to make recommendations on the liberalization of telecommunications. The report submitted by this four member committee chaired by the Director of Telecommunications is generally recognized as the beginning of the restructuring process. It recommended the creation of a regulatory authority and the grant of multiple licences to operators wishing to provide value added services, key element of the 1991 restructuring.

Around the time of this report (known as Gunawardane Report) news reports and rumors of an impending sale of the Department of Telecommunications to a foreign carrier began to circulate widely. The appointment of the "Shadow Board" in 1986 headed by a renowned Sri Lankan career diplomat strengthened the general perception that a foreign company was likely to take over the operations of the Department of Telecommunications upon privatization. The mandate of the Shadow Board included :

(a) Making recommendations on restructuring the department on a commercial basis.

(b) Formulating proposals on the establishment of a regulatory body.

(c) Assessing the need for foreign investment.

(d) Selecting an appropriate foreign partner.

By 1987 it was widely believed that the privatization would occur, with a minority ownership stake and management going to a foreign company. Cable and Wireless - a British transnational active in the third world was said to be the leading contender. (Interestingly, Cable and Wireless had operated in Sri Lanka's international telephone and telegraph services from 1941 to 1951 when the government took over services paying the company a compensation). During this period proposed privatization was quite opposed by the trade unions representing the employees of the Department of Telecommunications and associate organizations. They were primarily concerned by the loss of employment. This was justified because inefficiency, exemplified by a high employee / DEL ratio is one of the rationales for privatization.

With various delegations by the trade unions as well as the prevailing political situation in the island (with the Government signing an accord with neighbouring India etc) postponed the privatization of the telecommunication services. When Mr. R. Premadasa, nominee of the ruling party was elected as the president during a most chaotic and violent period in the midst of a massive insurgency and a civil war, trade unions obtained the views of most political parties who participated in the elections. All, except a tiny group stated that they were not committed to privatization of telecommunication services. President Premadasa decided against the privatization of telecommunication in 1989 and instructed his officials to prepare legislation to corporatize the Department of Telecommunications. This time, the unions acquiesced, notified by a Government commitment that no employees would lose their jobs.

Second stage of the institutional reform of the Sri Lankan telecommunication system consisted of three distinct but related processes namely :

(a) Establishment of regulation
(b) Corporatization
(c) Introduction of competition

Sri Lanka Telecommunications Act No. 25 of 1991 enacted in July 1991 is of central importance to all three processes. Parts I and II of this legislation creates a regulatory authority, the office of the Director General of Telecommunications, and specifies the powers of authority. Part III transfers all assets and liabilities of the Department of Telecommunications (SLTD) to the newly created fully government owned statutory corporation known as Sri Lanka Telecom (SLT), unless specifically excluded by agreement between Minister and Corporation. Part IV provides for the transfer of employees from the Department to SLT. Provisions defining rights of eminent domain for telecommunication operators are set out in Part V of the act and various offenses pertaining to telecommunication operators are described in Part VI.

Prior to 1991 there was no telecommunication regulation. The regulatory authority created by the Act consists of one person, and not multiple commissioners as in the case in most jurisdictions. Minister of Telecommunication was given broad powers and can over-rule the Director General. Sri Lankan telecom regulatory hence created is quite different from the conventional US regulatory agency which is given a degree of independence from the executive and legislative branches. The fairness of Sri Lankan authority's decisions appears to be safeguarded only by the conventional Westminster principle of ministerial accountability to parliament. For more details of the Telecommunications Act reference 1 is suggested.

In February 1990, Sri Lanka Telecom, the successor to the Department of Telecommunications was established by an incorporation order under the provisions of the State Industrial Corporations Act (No. 49 of 1957) and what the Telecommunication Act did was to fill this empty shell with the assets, liabilities and the employees of the Department of Telecommunications. One month after the Act came into effect the Minister on recommendation of the Telecom Authority engendered by the Act issued a 20 year licence to SLT completing the process of corporatization of the Government Department.

With the formation of the SLT, licence issued to SLT specified the ranges of authorized services namely telephone service, public telegraph service, telex service, data transmission, maritime mobile service, facsimile service, international television transmission, international photo telegram service, voice cast transmission, IDS (SATNET) service and INMARSAT service. However services such as pay phone services, cellular services and paging service have been left out of the licence.

4. PRIVATE TELECOM SERVICE OPERATORS AND THEIR ENTRY INTO THE SERVICE

Though the Telecommunications Act provides the basic framework for competition, actual competition was commenced prior to its enactment. The resale activities of the telecommunication bureaus described in previous paragraphs were a form of very rudimentary competition. More significantly, the first licence for cellular service was issued to Celltel Lanka Limited - a company owned by two foreign companies - Millicom International Inc and Comwick Inc of Sweden with several local business partners. This company which was established in 1987 was able to get a licence from Sri Lankan Government in late 1988 and the decision by the Government was more or less a political decision than an element of a corporate plan of the reform process planned. The company which commenced its operations at a time there was quite a lot of political turmoil due to terrorist activities etc, was issued only with a license to operate voice services and the intention of the company was to be the first and only cellular operator in the island.

The decision of the company to own there own cellular switches and the transmission backbone employing about 35 employees at the early stages has helped it to grow up to about 95 employees and now provides the service to over 4,000+ cellular subscribers in the metropolitan Colombo area and several other cities in the island. The equipment for the base stations and the switches were supplied by Motorola and the transmission equipment were supplied by Telescience Inc. Ownership as at today is changed due to two reasons namely the merger of Millicom Inc and Comwick Corporation of Sweden (as Millicom International Cellular) and the Sri Lankan partnerships also being changed. Currently the company is operated under its chief executive officer, Mr Johan Hall with over 80% shares owned by Millicom International and balance 20% owned by American Pension Fund and private (Sri Lankan) individuals.

This company was faced with heavy competition in the recent past as several other cellular players have entered the competition and offered competitive rates for the cellular services. The company which operates its cellular services in the 900 MHz band using ETAC-B has just provided its new services in the mountain capital - Nuwara Eliya recently using SLT microwave site co-locating the equipment temporarily for a six month period even though their policy was to independently select and operate sites without making use of the SLT equipment or sites. Their current transmission equipment utilization is around 20% and expansion plans of the company intend to make use of this unused capacity soon to face the competition. It has also been experimenting with very special rate structures during the second and third quarters of 1993 where nine different packages were offered. Recently they have offered another special rate for the subscribers where they could pay a very much lower rate to four frequently called numbers. For details of these reader may refer to references 2 and 3.

The Government's decision in 1988 to allow this company to operate a private cellular service in the Colombo metropolitan area was a practical incentive for the reform process as at this point the company was able to offer a non SLTD dependent switching of (cellular) calls for at least limited number of rich cellular subscribers. However this company now faces a fair amount of competition from several new operators some of whose activities will be described in this paper. Company believes that the SLT's decision to separate the business and regulatory processes was a correct decision even though allowing competition too much may lead to deterioration of the overall services. Celltel Lanka operates under a seven year licence issued by the Government of Sri Lanka in 1988 with an invested capital over US$ 8 million.

5. NEW CELLULAR OPERATORS AND THE COMPETITION

With success of the Celltel Lanka Limited and the formation of SLT and the regulatory body etc several other competitors have entered the cellular market in the island. Most new companies such as Call Link [legally known as Lanka Cellular Services (Pvt) Ltd] and Mobitel [legally known as OTC Australia (Pvt) Ltd] seem to have seen the country's economic progress and the industrialization as positive incentives for competing with the cellular monopoly by Celltel. Mobitel - a wholly owned operation by OTC Australia which established the operations in December 1992 was able to get the licence from SLT in February 1993 with an investment of approximately US$ 4 million. Within a short period the company had been able to reach a customer base of almost 25% of the customer base of Celltel and have established their services in metropolitan Colombo area and several other major cities. The operation was licensed by the SLT under the relatively untried Build Operate and Transfer (BOT) scheme. Their other strategy was to make use of SLT equipment sites and the backbone links to save equipment costs. Within an year the company plans to multiply the customer base by approximately six times as the Government has provided a temporary duty waiver for the importation of cellular phones very recently. In three years time company expects to multiply the customer base by approximately 20 times according to its Managing Director - Mr. Vijendran Watson. The company is expected to earn its profits and transfer the operation back to SLT under the terms and conditions of their seven year BOT licence. The company introduced a very attractive "flexiplan" tariff structure where subscribers could select one out of several tariff plans to suit their needs. The experienced player - Celltel seems to have considered a similar scheme to face the competition to keep their growth rate around 45% per annum. One special service offered by Mobitel was to guarantee the radio coverage along the coastal belt covering the capital Colombo. Their speedier facility built-up seems to be due to their BOT agreement with SLT which has supported the use of SLT facilities under co-location.

Another cellular operator - Call Link - legally known as the Lanka Cellular Services (Pvt) Limited was set up as a result of an initial investment from Singapore Telecom International, International Finance Corporation and Capital Development Investment Corporation. This company established in early 1992 with approximately 15 million dollars employ about 90 staff members. It is presently competing for a fair share of the new subscribers.

Almost all these companies attempt to compete for the cellular service in the metropolitan Colombo areas and the other major cities and the overall mobile subscriber base seems to be presently reaching over 3% of the total land lines presently in operation. Another important observation may be that the cost of initial connection charges which seem to have come down due to duty waivers etc and may be only 1.5 times approximately of the cost of a land line. The call charges also have come down drastically due to competition even though it is yet high compared to the POTS provided by the SLT. These companies operate using different standards and seems to be experiencing severe interference problems due to inadequately managed spectrum. Meanwhile the regulatory body has invested about 2 million US$ on a Spectrum Monitoring System to help these operators as well as other radio equipment users.

6. DATA NETWORKS, FAX SERVICES AND TRUNK SERVICES ETC

With demand for special services such as data networks, fax services, trunk radio systems as well as pay phones etc the services provided by the SLT were not at all adequate to meet the demand and the reputation for service reliability by SLTD or SLT was not accepted by the business community. New operators were prepared to venture into these areas and several companies have been set up to provide these profitably and Table 1 is an incomplete list of new companies and their services.

Lanka Communication Services (Pvt) Limited - more practically known as Datanet - is a joint venture (similar to Call Link and managed under the same Managing Director - Mr. Mitherpal Singh) between Singapore Telecom International and the Capital Development Investment Corporation of Sri Lanka. This company has been granted Recognized Private Operator Agency (RPOA) status which permits them to provide for International connectivity. The company is given a licence for 20 years to operate providing data and related services on an island-wide basis. The company uses its own F1 Standard Earth Station supplied by GTE.

Electroteks (Pvt) Limited is one of the pioneering telecom companies in the island which was originally designing, manufacturing and supplying telecom products to the SLTD and SLT for a period of over 10 years and this is one of the few companies which has not established any joint venture partnerships with foreign companies. The company being set up by an ex-telecom chief engineer was also pioneering into the area of radio links and banking services and this company presently supports over 70% of radio links for Automatic Teller Machines (ATM) etc of the metropolitan area branches of most successful Banks. The company with its intrinsic engineering capability and the confidence under its Managing Director - Mr. Chandraratne Abeywardane has recently commissioned its Private INTELSAT Gateway and the data / fax network investing over US$ 0.5 million. The new data network service of this company is creating a direct competition for the services established by Datanet few years back.

There are more than five companies who operate paging services and one company - Lanka Pay Phone Services has established a pay phone service including IDD facilities where users can make use of phone cards.

7. TRUNK NETWORKS

Sri Lanka's first public 800 MHz trunked radio system is now in operation. A local company - Dynacom Engineering Trunking (Pte) Ltd has commenced its services with the management and consultancy services proposed by Motorola Inc. The system now in operation provides a radio coverage of about 30 miles centered around Colombo using rented radio telephones. The company has quickly grown up to about 200 users with just five repeaters in the 800 MHz band and the users are relieved from the difficulties of getting the frequency allocations from regulatory body. Company has invested approximately US$ 2 million according to its General Manager - Mr. Uoosoof Mohideen. The user community seems to be a variety of business customers such as container / freight forwarders, construction firms and many others who need the radio connections for short messages of 10 to 20 second duration. Before the end of year 1993 company is determined to increase the customer base by installing 10 more repeater sites.

8. PROPOSED NEW VENTURES

It is very interesting to see that the new developments related to telecom expansions have allowed the most successful corporate bodies (who were not traditional telecom related business houses) to plan on new ventures related to telecom infrastructure facilities. For example, Maharaja Organization - one of the most successful business houses in Sri Lanka - has just established two new joint ventures namely : Maharaja Transmission Tower Network (MTTN) and Maharaja Telephone Network (MTN). Joint venture partners for these projects are - Finnish Telecom, FinnFund and a subsidiary of Maharaja organization - Sun Power Systems Limited. MTN is a US$ 6 million project to provide cellular phone services and MTTN is US$ 2.2 million project to provide a radio transmission infrastructure with an island-wide radio links which can be rented for different users including the radio and television broadcasters.

First phases of these projects will be in operation by early 1994 and the company expects some competition by SLT itself, according to the Director of Sunpower Systems - Mr. Jayantha Samarakoon.

9. FUTURE

Considering the success of the private telecom operators entering the potential telecom market in the island it appears that the lower telecom penetration will be soon improved and the competition may allow the new subscribers to get better services at relatively lower costs. By promoting such ventures by offering various incentives such as Board Of Investment (BOI) recognition (which allows tax holidays and duty free imports etc), the Government encourages foreign vendors to enter the Sri Lankan telecommunication market. This may relieve the Government owned corporation - SLT to raise funds to provide special services but allows it to reach their goals in providing very high penetration levels of POTS. The Director General of Sri Lanka Telecom regulatory body has now called for proposals for two special projects : a video conferencing facility (to cover three free trade zones and metropolitan Colombo areas) and a common air interface / CT2 based service. Meanwhile the Ministry of Posts and Telecommunications is planning to call for proposals for GSM based cellular service very soon.

10. CONCLUSION

The paper discusses the success and the competition created by the new private telecom operators in the island and clearly indicates how more modern and advanced methods of communication could compete with the POTS in the third world countries to provide higher telecommunication penetration levels.

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Table 1

Company	Year of Formation	Service
Lanka Communication Services (Pvt) Ltd	1991	datacom / fax / telex
Electroteks (Pvt) Ltd	1983	datacom / fax
Dynacom Engineering Trunking (Pte) Ltd	1993	trunk radio

FORGING NEW LINKS, OR MAINTAINING THE STATUS QUO?

Telecommunications & Information Technologies in Pacific Islands Development

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1 Abstract

This paper examines the impact and implications of telecommunications and information technologies against the backdrop of development aspirations in three "representative" Pacific Island nations; namely the Cook Islands, the Republic of Fiji and Papua New Guinea. These three countries represent a wide range of development potential from the relatively mature export economy of Fiji to resource rich Papua New Guinea to the tourism dependent Cook Islands, as well as providing a sampling of the divergent approaches to development and the perceived role that technology is expected to play. This paper will specifically focus on the broad social, economic, and political impact of recent telecommunications developments. Such developments will be considered in light of each country's individual development programs and their common desire to increase their respective participation in the global economy. It will be argued that if development aspirations are to be realized, respective national telecommunication policies must attempt to achieve multiple objectives: some are economic, and some are social. Finally, placing such an examination in a regional context, the country case studies are used as the background used to generate three alternative scenarios from which policy considerations are examined and possible recommendations discussed.

In the wake of the 1984 Maitland Commission report, numerous correlation analyses were done that revealed the importance of telecommunications as a required infrastructure for development and as a component of investment planning like roads, power supply and irrigation (*cf.* an earlier work by Saunders, Warford & Wellenius 1983). Such statistical correlation does not prove causality, but developed and developing countries alike are finding that greater emphasis has to be places on telecommunications services as catalysts for economic growth and social change. Furthermore, telecommunication technologies are also being increasingly viewed as sources of global competitive advantage, as providers of social and welfare benefits, as contributing to reducing urban-rural disparities, and as providers of information for the general edification of the population. However, even in the more developed countries of the Pacific Rim, telecommunication technologies have only recently become dominant concerns in the formulation of national development policies; even as the Uruguay Round of GATT negotiations served to illustrate that information and knowledge are increasingly being considered strategic resources and telecommunications the primary means determining their availability (Pipe 1990). It is also increasingly evident that telecommunication matters are becoming important for national, economic, and social policy formulation in all countries. As such, it seems equally important that a policy framework for making telecommunications a truly universal resource will need to emerge in the near future (Hansen, *et al* 1989).

However, for many developing countries one of the central problems is how to ensure that the existing telecommunications infrastructure incorporates new technical developments efficiently to satisfy the demands of urban users, while at the same time maintaining the provision of the more "traditional" services – telex, HF and single side band radio for example – where such services are the most effective, and sometimes the only service available to many rural users. No where are such concerns of more pressing importance than in the far-flung island states of the Pacific Basin.

As telecommunications technologies become an increasing presence in the lives of the people of the Pacific Islands, their nascent economies are at the same time being converted into a vital synergetic region offering market opportunities to vendors in the advanced countries. However, as eager as island governments are to engage multinational telecommunications companies in assisting them (through joint-ventures or otherwise) in improving and expanding their domestic infrastructure and international "teleconnectivity," in the overall scheme of their national development equal (if not more) importance is placed on the issue of self-reliance. Of particular interest in this regard is the widespread view that such "technology for development," when combined with policy and structural adjustments, presents a new "panacea" for the revival of stagnant, dormant, and developing economies. It is often further assumed that if appropriate telecommunication technologies are "successfully transferred," than self-reliance will surely ensue. However, "technology for development" almost invariably means the introduction of an external – and thus, foreign – technology, laden with overt as well as hidden linkages which could have the effect of undermining the goal of self-reliance. In this regard, many Pacific Islanders' vision of development includes the introduction of "necessary" or "appropriate" telecommunication (and other) technologies that assist in economic growth and/or promote a higher quality of life (Dator, *et al.* 1986, Ogden 1993), existing along side the somewhat incongruous desire to avoid further technological dependency.

Faced with such a quandary, the focus of this paper is to attempt to understand the development constraints, concerns, and desires in the Pacific Islands context while examining the role of telecommunication technology in realizing the Islanders' expressed goals of "self-reliant development." From an examination of three country case studies – namely, the Cook

Islands, the Republic of Fiji and Papua New Guinea (PNG) – it is hoped that a clearer picture of development aspirations can be obtained. When combined with the expected role telecommunications is to play in meeting these development aspirations, the impact of such technology can be assessed in the context of its application. Finally, when placed within a time-frame of approximately 30 years, alternative scenarios of technology and development can lead to an understanding of the sometimes subtle nuances of policy choice, both now, and in the future.

2 Constraints on Pacific Islands Development

There has emerged within the past decade a considerable body of literature examining the economic performance and policies of small developing states (1). Of the significant conclusions drawn from this analysis, one fact stand out clearly; "smallness" is not necessarily a handicap to development (Streeten 1993). This is primarily because small nations are less likely to pursue costly inward-looking development strategies, since the limits to import substitution are readily apparent. Small island countries are, in particular, quintessentially open economies, with the value of merchandise trade frequently exceeding 75 percent of GDP which requires careful macroeconomic management to maintain internal and external balance as well as competitiveness (Elek, Hill & Tabor 1993). Most small states are also able to change policy directions far more quickly and, with a few sizable investments in response to policy reforms, they can swiftly alter the shape of their economy (Elek, Hill & Tabor 1993, Dommen 1980). Moreover, small states – by their very "smallness" being commercially non-threatening – are able to achieve market access (e.g., SPARTECA, which grants Pacific Island nations preferential access to Australian and New Zealand markets) and avoid discriminatory trade treatment more easily than larger countries. Nevertheless, the nations and territories of Micronesia, Melanesia and Polynesia, scattered over approximately 29 million square kilometers of the Pacific Ocean with rapidly growing and increasingly youthful populations, are confronted with diverse, and at times severe, developmental constraints (see Table 1). Possessing small and fragmented land masses – ranging in size from PNG which occupies 88 percent of the total regional land area, to Niue which is a single coral islands – the Pacific Island nations are separated by long distances from their major trading partners and are extremely vulnerable to natural disasters.

Since independence, many Pacific Island nations have also experienced deteriorating terms of trade – typically with heavy dependence upon one commodity – and imports in excess of their exports. Most Pacific Island nations also suffer from severe foreign exchange shortages, poor terms of credit and human resource development problems.

With the exception of Nauru, all have aid-dependent, or at least aid-augmented, economies with a total per capita aid flow ranging from US$62 in Fiji to US$2,800 in Niue. Likewise, in the form of direct budgetary aid, such financial assistance comprised over 21 percent of the total revenue for all Pacific Island nations for 1990 (*SPC* 1993). The per capita gross national product (GNP) also varies widely, ranging from US$430 in Tuvalu to US$1,770 in Fiji and US$1,958 in the Cook Islands.

In attempting to address these difficulties, the decade of the 1980s saw the rise of more assertive and nationalistic Pacific Island policies. In pursuing such policies, technology transfer became a growing problem in terms of financing and potential impact. This is especially poignant considering technology accounts for 50 percent of total imports entering the Pacific Islands region – in the form of direct imports and as aid – and that imported technology represents around 70 percent of total technology transfer, with aid (mostly from Japan, United States, Australia and New Zealand) constituting around 30 percent of such transfers (Marjoram 1990). This indeed presents a daunting task for the fragile and open economies of the Pacific Islands as they chart their own development policies with a view to retaining their cultural and political integrity in the face of technology driven change.

The decade of the 1990s is now beginning to see Pacific Island countries becoming more visible and vocal players on matters of development and technology through such regional organizations as the South Pacific Commission, the South Pacific Forum and its Forum Telecommunications Project, the Asia-Pacific Telecommunity (based in Bangkok, Thailand), and the International Telecommunications Union's Bureau for Development Telecommunications. Based in Hawaii, the Pacific Telecommunications Council is also actively promoting studies in the Pacific Islands and subsidizes the participation of their representatives at its annual conferences. These changes indicate a strong desire on the part of policy makers in these countries to actively promote telecommunication improvements and establish global linkages.

Presently, all of the Pacific Island nations have INTELSAT satellite gateways for international telecommunications (Table 2) and many have embarked on ambitious modernization plans following a restructuring of their telecommunications organizations, while still others have entered into joint-venture agreements for the management of their international and domestic communications. Emerging developments like digitization of satellite systems with DAMA (Demand Assigned Multiple Access) and TDMA (Time Division Multiple Access) along with Very Small Aperture Terminals (VSATs) for receiving satellite signals are assisting the thin-route systems in the Pacific Islands, making them less costly and more efficient. Thin-route, repeaterless fiber optic technology is also making inroads as costs come down and bandwidth demands rise. Much of this effort has come about through the recognition of telecommunications' contribution to economic growth and its importance to international trade. Whereas telephone density (number of telephones per 100 population) and subscriber waiting lists (Table 3) in the Pacific Islands have greatly improved since the mid-1980s (*cf.*, Jussawalla & Ogden 1989) and are much better than in some developing countries (2), the greatest share of the telephones are still concentrated in only a few urban areas while in most Pacific Island countries the bulk of their population living in the rural interior and/or outer islands languish without service. Efforts have been initiated to rectify this desparity (Ogden & Holloway 1988; Masterton 1989; Ogden 1989) but no substantial results are as yet being reported. In the end, perhaps, the cost of opting out of implementing the application of such technology may, in the long run, prove to be higher than the investment cost of their introduction. It is anticipated that before the turn of this century, with appropriate organization, the Pacific Islands can have economic, financially affordable access not only to point-to-point communications but to national radio and television broadcasting as well, should they desire such services. The only missing factor seems to be appropriate organization at the government and private sector levels for financial and technical inputs into the strategy of optimizing investments in telecommunications technology while at the same time putting into place policies aimed at maximizing the potential benefits of such technology transfer while delimiting negative externalities.

In the following three sections, we will examine the above mentioned issues and policy concerns in the context of the economies and development aspirations of three Pacific Island countries.

3 Cook Islands Case Study (3)

The Cook Islands comprise 15 islands divided into a Northern Group of predominantly atolls, and a Southern Group of mostly high volcanic and/or raised coral islands. The total land area is approximately 237 square kilometers in a sea area of 1,830,000 square kilometers. The main island is Rarotonga, on which the capital Avarua is located, and accounts for nearly 60 percent of the population with the remainder of the Southern Group accounting for another 29 percent while the Northern Group comprises the remaining 12 percent of the total Cook Islands population. The 1991 census puts the population of the Cook Islands at 18,552 reflecting nearly a 6 percent increase since the last census in 1986 (much of this due to return migration). This counters a long standing trend of negative net population growth as large numbers of Cook Islanders migrated to either New Zealand or Australia seeking better employment and education opportunities. There are presently estimated to be over 20,000 Cook Islanders living in New Zealand and/or Australia.

3.1 Development Efforts

The Cook Islands experience substantial constraints on its economic development primarily due to the scattered nature of the archipelago, remoteness from markets, dis-economies of scale in transportation and increasing competition for market share with other developing agricultural countries in the Pacific region. In the past, the main export cash crops have been bananas, pineapples, papayas, citrus, and other fruits along with vegetables and root crops. However, the agricultural production of the Cook Islands in 1989 was reported to have fallen by approximately 20 percent from 1981 levels and further decline is expected. In an attempt to address this problem, the Ministry of Agriculture is attempting to lead away from bulky, perishable crops which had been the mainstay of export agriculture in the past, to those with longer storage life and ease of transport without quarantine restrictions; such as arabica coffee and vanilla. This is currently being met with a modest amount of success.

However, it is the backward and forward linkages associated with the tourism industry that has caused the Cook Islands government to identify it as the lead sector for economic development. Between 1972 and the end of 1991, visitor numbers to the Cook Islands have more than trebled from approximately 10,000 to over 30,000 arrivals per year. The tourism industry is estimated to be worth approximately US$18.4 million annually, making it the major foreign exchange earner for the Cook Islands economy.

The significance of this industry is most obviously represented by the shift in the structure of local employment patterns. The tourism and related services sector now accounts for over 65 percent of total employment compared with 55 percent in 1971. The primary and secondary levels each account for 16 percent of total Cook Islands employment with an additional 6 percent remaining unspecified. It is expected that the importance of the tourism industry to future economic growth is likely to continue; provided the special attractions which draw tourists to the Cook Islands in the first place are not destroyed in the process (CITA 1991). It is ventured that the appeal of the Cook Islands is derived mostly from a blend of the friendly and hospitable people and the resplendent scenery.

Although the marine resources of the Cook Islands have received increased attention in the past few years, there has been only limited harvest of pelagic fish resources within its 200 mile exclusive economic zone (EEZ) and an even more limited exploitation of artisanal fisheries – primarily for personal consumption or to supply the local market. It is, however, the lucrative and expanding pearl industry in the Northern Group which has received the most attention. Currently, and since 1985, the focus has been on the farming of pearl oysters for both cultured pearl and shell on Manihiki, with Penryhn and Suwarrow currently under investigation for possible expansion sites. Other commercial lagoon fisheries include trochus and the re-introduction of giant clams. Eatable seaweed was introduced in the early 1980s, but was wiped out by hurricane Sally several years later and never restarted. The Cook Islands also control within its 200 mile EEZ, an estimated 25 percent of the worlds cobalt reserves (in the form of crust deposits on sea mounts and the ocean floor). Whereas the cost of accessing this potential mineral resource is presently prohibitive, it is expected that in the future the Cook Islands will be able to successfully exploit these deposits to their economic benefit.

Economic development in the Cook Islands has been quite volatile, but on a general upward trend. There has been noticeable increases in per capita income, but typically only for the residents on Rarotonga, with little improvement being realized in the outer islands (Manihiki with its pearl industry, and Aitutaki with tourism, being the notable exceptions). GDP growth between 1983 and 1990 averaged 6 percent with sharp upward and downward surges with drops of between 7 and 11 percent; further illustrating the enormous volatility of the GDP growth rate to global conditions and the "boom" or "bust" nature of economic development. As well, this also serves to illustrate the significant role government infrastructure expenditure and development investments have played in Cook Islands economic activity.

Finally, the Cook Islands offshore financial center is credited with infusing new life into the finance and business services sector which has grown from approximately 2.5 percent of GDP in 1982, to 12 percent in 1990. When taken together with other service related sectors, including tourism and government activities, value-added services account for almost 77 percent of GDP in 1990, while agriculture and fishing contributed less than 18 percent. This indicates a shift from a predominantly agriculture production oriented economy, to a tourism lead service economy over the course of the past decade.

3.2 Telecommunications

As the Cook Islands shifts more and more into a tourism lead service economy, good quality, reliable international and domestic telecommunications have become very important. The opinion among many in the Cook Islands is that they need to be "plugged in" to the global telecommunications system for hotel reservations, air transportation, international business communications, etc. It is further perceived that such developments would also go a long way towards fostering continued growth in offshore banking. The Cook Islands is currently the only off-shore facility in the Pacific with registered listed companies approved by the Hong Kong stock exchange and only the third jurisdiction, following Bermuda and the Cayman Islands, to obtain such approval (Miller 1991). Obviously, good quality and reliable international connectivity on demand is required to facilitate such connections. Likewise, the growing pearl industry and tourism's expansion into the outer islands also requires extending the same type and caliber of communication services that are available in Rarotonga into these locations. Proponents argue that if the Cook Islands want to be part of the global network, and if it wants the tourist industry to grow and succeed – especially in the outer islands – than it must have efficient and reliable telecommunications.

This argument, along with expressed political will, has been used by the present government to justify not only the introduction and expansion of broadcast television services on Rarotonga and to the outer islands, but also an approximately US$10 million loan from the Asian Development Bank (ADB) and Export Credit Finance organization of Australia for the country's telecommunications development. Likewise, following the setting up of a joint-venture telecommunications corporation, Telecom Cook Islands, Ltd. (TCI) in 1989 (4), the government then forced early contract termination and compulsory acquisition of Cable and Wireless operations in the Cook Islands by legislative act in 1991. It was argued that the Cable and Wireless monopoly prevented the government from putting in to place its plans for the joint development of outer island and international telecommunications. Therefore, the provision of telecommunications services were determined to constitute a "public purpose," and the monopoly agreement was terminated with a decision on adequate compensation to Cable and Wireless going to arbitration.

By Christmas 1989, most of Rarotonga had broadcast television coverage as a "Christmas gift" from the government. In December 1990, Aitutaki became the first of the outer islands to be provided broadcast television coverage (with service again being offered by Christmas). Just prior to the initiation of television service in Aitutaki, the old manual telephone exchange with 200 lines was upgraded to an automatic exchange with 300 line capacity (upgradable to 600) and is now provided with international direct dial for the first time. Mitiaro, another island in the Southern Group, also received an earth station and a small automatic exchange with international direct dial expected to be added soon. In total, approximately 6 outer islands will be connected via satellite to the domestic (and international) telecommunication system via the Pacific Area Cooperative Telecommunications (PACT) Network, while one will be connected via UHF (line of sight microwave) and the others will continue to be served by HF and single side band radio. The PACT Network is a regionally focused and operated DAMA satellite service designed and maintained by the Overseas Telecommunications Corporation, Inc. of Australia (OTCI), and put into service in 1989 (*cf.*, Masterton 1989). All of the inhabited islands in both the Northern and Southern Groups were expected to be connected into the national telecommunications system by as early as March 1993. This time-table faced a set-back due to the amount of time and resources expended to recover from a fire that destroyed the Avarua central switch in September 1992 (Tanaka 1993).

As of early 1992, The Cook Islands had a total of 25 incoming and 35 outgoing trunk lines available for international service via the (now) TCI Standard B earth station in Rarotonga. International direct dial accounted for 66 percent of these lines. Rarotonga, Aitutaki and most recently Mitiaro, are presently the only islands with direct dial telephone service, but expansion is proceeding to connect most of the other islands. Rarotonga presently has over 2,000 subscribers with residential subscribers comprising approximately 72 percent, business subscribers 26 percent, and the remaining 2 percent being public pay phones. There are an estimated 40-50 facsimile machines, mostly in Rarotonga, currently operated by Cook Islands businesses. Until the ADB loan was acquired, telecommunications growth in the Cook Islands was primarily a function of the ability of TCI to supply the service, since the waiting list for telephone hook-up was several years backlogged and the network was near capacity. In other words, network capacity and thus the supply of service could not keep pace with demand. With the initiation of the current modernization and expansion program, network capacity is expected to keep pace with subscriber demand with sufficient surplus and network expandability to meet future needs as they arise.

4 Republic of Fiji Case Study

Fiji is an archipelagic nation comprised of over 360 volcanic islands (approximately 93 of which are inhabited), with a total land area of 18,376 square kilometers and an Exclusive Economic Zone (EEZ) of approximately 1.29 million square kilometers. The largest island, Viti Levu, is 10,429 square kilometers in size, and the second largest, Vanua Levu, 5,556 square kilometers.

Bridging the gap between Melanesia and Polynesia (the indigenous Fijians – or *Taukei* – are ethnically and culturally a blending of the two), the Fiji group is situated between 15° and 22° south of the equator and approximately 2,730 kilometers northeast of Sydney, Australia, and 1,770 kilometers north of Auckland, New Zealand.

Fiji has a multiracial population approaching three-quarters of a million (742,000 by 1991 estimates). Indigenous Fijians form 49 percent of the population, Fiji Indians account for 46 percent, and the remaining 5 percent are Europeans, part-Europeans, Chinese and other Pacific Islanders (Treadgold 1992). Approximately 75 percent of Fiji's total population live on the main island of Viti Levu, with an additional 18 percent on Vanua Levu, and the remaining 7.2 percent living in the outer island groups. The majority of Fiji's population (61.3 percent), including 67.3 percent of the indigenous Fijians, live in rural areas where sugar, coconut, or other cash-cropping exists alongside subsistence agriculture as the main activities (Treadgold 1992).

As of the 1986 census, the agricultural sector accounted for nearly half of all employment (primarily in sugar production), while the industrial sector's share amounted to 15 percent, and the service and public sectors accounting for 31 percent (Bureau of Statistics 1986).. During this same time, Fiji's unemployment rate was approximately 7.5 percent. However, following the two coups of 1987 and the resulting downward projection in employment trends coupled with increases in the available labor force, a sharp increase occurred in unemployment reaching over 10 percent by some official estimates. Since the coups, paid employment has increased by about 15 percent with most of the new jobs appearing in the manufacturing sector under the Tax Free Factories scheme of which the garment industry has been the main beneficiary (Treadgold 1992). The result has been a net fall in the recorded rate of unemployment to 6.4 percent in 1990.

The numbers are not as good as they appear since, during the same time period, real wages were 16 percent below their 1986 level and as much as 22 percent below their 1981 level. This in part reflects two major devaluations of the Fiji currency, a general wage freeze and a 15 percent cut in public sector wages and salaries in 1987 following the two coups.

4.1 Development Efforts

Classified by the World Bank as a lower-middle-income economy, Fiji compares well with many other developing countries in terms of a range of social indicators. Indeed, prior to the two coups of 1987, Fiji was arguably the most developed South Pacific island economy (Hamnett & Ogden 1988). Fiji returned to "normalcy" relatively quickly, culminating in the establishment of a newly elected civilian government in 1992 under a revised constitution. However, the internal turmoil that precipitated from the coups and the political uncertainty that continues to persist, combined with substantial political jockeying after the election, has left its mark on the economy. This has resulted in the likelihood that such political "jousting" will remain a significant factor affecting Fiji's economic development. The recent return to parliamentary government is a good sign, but whether it presages a more settled political future remains to be seen. Through it all, however, Fiji remained (and is still today) the regional hub for communications, many regional organizations, aid programs, education, and, to some extent, trade.

Against this backdrop, the growth performance of the economy over the past decade has been characterized by short-term instability and long-term sluggishness (Treadgold 1992). Real GDP per capita in 1991 was virtually no higher than it had been in 1981. This stagnation (overall GDP growth averaging less than 1 percent) was the result of faltering growth in the sugar industry due to a series of natural disasters and a prolonged depression in world prices combined with an inward-looking, highly regulated development strategy (Treadgold 1992; Sturton & McGregor 1991). The current economic situation is one of recovery from a sluggish position in 1991 when real GDP declined by 0.4 percent, to an estimated 4 to 5 percent increase in GDP for 1992. This growth can be attributed to some improvement in commodity prices and increases in sugar and garments production. By World Bank and IMF standards, the overall macro-economic situation is fundamentally sound and characterized by a high degree of stability, with inflation at just over 4 percent, the balance of payments generally in surplus, and international reserves at a post-coup high (EIU 1993).

The primary production sectors are facing somewhat mixed prospects for export earnings. Copra and cocoa are expected to show some recovery as prices improve. Ginger exports, particularly to the United States, could expand significantly with adequate attention paid to quality and with proper marketing (McGregor 1988). Commercial tuna fisheries are expected to stabilize at the 20,000 ton mark of canned tuna while a rapid expansion of fresh sashimi to Japan is expected to continue as increased airline traffic between Fiji and Japan is implemented. Forest products also have significant growth potential as substantial investment in pine and hardwood plantations begin to come into production. A modest increase in gold production is expected from the existing Vatukoula mine with a new, smaller project at Mt. Kasi expected to produce approximately 1 tone of gold annually with other new gold prospects showing promise (Sturton & McGregor 1991).

Tourism is the second largest industry in Fiji with $US224.5 million in revenue generated from 278,534 visitors in 1992 (Keith-Reid 1993a). This represents a 7.4 percent increase over 1991's sluggish performance and nearly matches 1990's record high of 280,000 tourist arrivals. Despite these figures, the hotel industry is grumbling that they only averaged 51 percent occupancy rates for 1992, contending that they needed at least 70 percent occupancy to make a comfortable return (Keith-Reid 1993a). Much of the blame for the post-coup down-turn in tourist arrivals has been levied at the on-going recessions experienced in Australia and New Zealand which, taken together, account for nearly 45 percent of Fiji's tourist arrivals. However, longer-term prospects remain good, with many hotel and resort investment prospects in the works. There is also evidence of a growing market in Japan and the United States, although much will depend on Fiji's capacity to maintain competitiveness and promotional efforts in the face of growing competition from other South Pacific destinations.

In 1987, Fiji's interim government actively promoted a tax-free factories scheme to restore investor confidence offering up to a 13 year tax holiday for some businesses. This coincided with significant changes in the South Pacific Regional Trade and Economic Cooperation Agreement (SPARTECA), which improved the access of Pacific Island manufactured goods to the Australian and New Zealand markets. Garment manufacturers in both Australia and New Zealand responded rapidly to both developments and now many of the best known name brand garments in Australia and New Zealand are manufactured in Fiji. Garment exports to the United States are also important, and account for approximately 10 percent of garments exported and is likely to increase significantly (Sturton & McGregor 1991). Thus, in little over four years the garment industry became Fiji's second largest export earner after sugar and third major industry (after tourism). In 1991, the garment industry accounted for exports worth approximately US$113 million and employed 12,000 persons (mostly women). At present, the industry appears to be entering a consolidation phase, but is expected to grow by at least 10 percent. Future prospects will depend upon the capacity to compete with low cost Asian producers and to develop specialized products geared to niche markets (Fairbairn 1992).

4.2 Telecommunications Developments

The telephone system in Fiji was first introduced in 1895 by the Colonial Sugar Refinery Company in the early days of the sugar industry. Taken over by the colonial government in 1910, the communication system went through many changes; from the initial operation using hand-cranked magneto telephones through "step-by-step" manual exchanges and automatic cross-bar exchanges to the anticipated total digitalization of the system by 1994. Likewise, Fiji was among the first Pacific Islands to be connected to the international submarine cable network, starting in 1921 with the telegraphic cable. In 1963-64, Fiji was connected to the Pacific section of the Commonwealth round-the-world cable system (COMPAC) which gave Fiji high-quality telephone links to the other COMPAC partners (Australia, New Zealand, and Canada), and through them to the rest of the world.

After independence in 1970, and with rapid growth in commerce, industry and tourism, the need for enhanced capacity and diversity of routes led to the addition of international satellite facilities. In 1976, Fiji International Telecommunications, Ltd. (FINTEL) was formed to provide for Fiji's international

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communications needs. A private company jointly owned by Cable and Wireless plc of Britain (49 percent share) and the Fiji government (51 percent share), FINTEL is licensed by the government to operate the submarine coaxial cable terminal as well as the INTELSAT satellite terminal, both located at the Vatuwaqa Communications Center. FINTEL initiated a nearly US$2 million program to convert its earth station from analog to digital in 1992, more than doubling international capacity and allowing Fiji to better integrate with the global digital network. FINTEL's largest single investment to date has been US$7.59 million in the digital ANZCAN transpacific cable which links Fiji to Australia, New Zealand, Hawaii, and Canada.

FINTEL has also been a key player in the establishment of the INTELSAT satellite based distant teaching network for the University of the South Pacific (USP) allowing the university to provide audio teleconference based educational opportunities to students on its other campuses throughout the region.

In the last quarter of 1992, FINTEL joined the Pacific Area Cooperative Telecommunications Network (PACT Network) enabling it, for the first time, to provide direct links with Niue, Kiribati, Nauru, Tuvalu, and the Marshall and Cook Islands. Australia, New Zealand, Papua New Guinea and the Solomon Islands have also recently become members of the PACT Network. As well as providing direct telephone and facsimile services, the PACT Network enables Fiji and the other member countries to offer high-quality, specialized services to agencies involved in distance education, civil aviation, and exchanges of research and other data throughout the recently introduced international packet switching service (*Fiji Times* 15 May 1993).

Responsible for domestic telecommunications services exclusively, Fiji's Posts and Telecommunications Ltd (FPTL), corporatized in 1989 (but still 100 percent government owned), is the largest commercially-run ex-departmental arm of the government with a staff of nearly 1,500 and a capital budget for 1993 of approximately US$21 million (Keith-Reid 1993b). FPTL commenced providing postal and telecommunications services in Fiji at the beginning of 1990 when the government – through the Posts and Telecommunications Decree of 1989 – turned over all assets and liabilities from the former Division of Posts and Telecommunications. Under a limited monopoly license granted by the minister responsible for telecommunications, FPTL is the exclusive provider of network services but faces competition in the provision of business PBXs and terminal apparatus. Postal services are handled by FPTL on behalf of the government with an exclusive monopoly on letter delivery and open competition on provision of other services.

Fiji's 1987 coups hit telecommunication services particularly hard; the then Department of Posts and Telecommunications had its connections to international services severed and certain communications were monitored, and it lost scores of engineers, technicians and managers who fled the country. Services have long since returned to normal and some skilled staff have returned, but the organization has had to make hefty reinvestments in training while coping with pressure for the expansion and improvement of telephone services. Despite these difficulties, and two years of declining profits, FPTL has averaged US$4.64 million in annual operating profits during the period 1984-1991, with 1992 showing a profit of approximately US$5.3 million (*Fiji Times* 12 April 1993). Over the past several years, FPTL has spent over US$1.6 million on computerizing the exchanges at Nadi, Namaka and Lautoka, and the Nadi and Namaka crossbar analog exchanges were replaced with electronic digital systems. Likewise, a digital microwave system was set-up between Suva (the capital) and Lautoka and fiber optic cables laid between Lautoka, Nadi and Namaka(*Fiji Times* 13 May 1993).

In May 1993, FPTL launched its nearly US$2 million FijiNet service, the country's first public packet switching network. The service allows customers to communicate by computer locally or overseas utilizing FINTEL's packet switch network. Initial service is available only in Suva, Labasa, Lautoka and the Coral Coast but there are plans to extend the service to other parts of Fiji (*Fiji Times* 4 May 1993). FPTL also recently introduced prepaid telephone debit cards for use on specially designed pay phones throughout Fiji which are now earning an estimated US$38,000 per month. Other expected infrastructure investments for 1993-94 include the continued digitization of exchanges to reduce costs and improve networking efficiency enabling FPTL to keep pace with an anticipated 10 percent annual growth in demand for services. It is hoped that by the end of 1993, 96 percent of all working exchange lines will be connected to a digital exchange (*Fiji Times* 15 May 1993). Also, a digital microwave system with a 1,920 channel capacity is anticipated to be installed between Nauva and Namaka providing an additional route from the southern to the western divisions and bringing improved network reliability. Additionally, there are plans for the provision of a 480 channel digital microwave system between Delaikoro in Vanua Levu and Des Vouex Peak on Taveuni. Finally, FPTL will soon award a US$1.28 million contract for the first phase of a cellular mobile telephone system to cover Suva, Ba, Lautoka, Nadi and Namaka (Keith-Reid 1993b). These developments are going a long way towards meeting the urban business and resident's demand for new and improved services. However, the concentration of telecommunications infrastructure in urban centers denies its benefits to the larger section of the population; the rural dwellers. This exacerbates the urban-rural dichotomy. Even as Fiji contemplates the introduction of permanent television service (presumably in the urban areas first), many in the rural areas are still without POTS – Plain Old Telephone Services – and the communication services that are available, such as HF and/or single side band radio, lag far behind those of their urban compatriots.

5 Papua New Guinea Case Study

Papua New Guinea (PNG) forms the eastern half of the island of New Guinea (the western half comprises the Indonesian province of Irian Jaya) and many off-shore islands comprising five separate archipelagos. To the south is Australia, to the east is the Solomon Islands, and to the north is Micronesia. The land area, approximately 462,243 square kilometers, includes the large islands of New Britain, New Ireland, and Bougainville, plus some 600 small islands. The mainland and larger islands have some of the most rugged mountains in the world. Over 75 percent of the land is covered with tropical rain forest while some of the broad low-land valleys and may highland valley systems are blessed with fertile soils, suitable for subsistence and/or commercial agriculture (Pintz 1988).

Approximately 85 percent of PNG's population live in rural interior and outer island areas, typically in small and isolated villages. About 40 percent of the over 3.5 million population live in the Highlands areas, with "urban" drift occurring towards the major Highlands centers of Mount Hagen and Goroka as well as to the lowland cities of Port Moresby (the nation's capital), Lae, and Madang. In terms of life expectancy (50 years) and infant mortality rate (72 per 1,000 births), PNG does not compare very favorably with other Pacific Island nations. Over 40 percent of the population are 14 years of age or younger and 55.5 percent are between 15 and 64 years, little over 1 percent are over 65 years of age. PNG's people are among the most heterogeneous in the world with over seven hundred distinct languages spoken among an estimated 1,000 different cultural groups. The isolation created by the rugged terrain and lack of infrastructure partially explain this diversity. The per capita GNP is around US$860 and while growth rates have been poor in recent years due to the crisis in Bougainville and the subsequent disruption in mining at the large Panguna copper mine, PNG recorded significant growth in 1991 with real GDP rising by 9.5 percent.

5.1 Development Efforts

Since independence, the PNG economy has experienced erratic economic growth primarily reliant on the export of agricultural, forestry and mineral production. Foreign aid has also helped supplement the national budget. In fact, PNG has always recorded large budget deficits, relying primarily on the Australian government for assistance in financing it – PNG already receives about US$204 million a year, or about 40 percent of Australia's total bilateral assistance, to cover its budgetary shortfall. However, with the onset of the recent mining boom and spin-offs from mining activities, combined with a recovery in the prices of some export commodities and an increase in government expenditure, real output has expanded by 50 percent. This growth represents a dramatic turnaround from the 1989-90 period when, as a consequence of the closure of the Bougainville copper/gold mine and steep decline in the terms of trade, real GDP fell by around 11 percent over the two year period (Fairbairn 1992). Furthermore, with production at the Kutubu oil field peaking at about 140,000 barrels per day (with estimated reserves of 250 million barrels) and forecasted stability in oil prices, merchandise export earnings are now expected to soar (EIU 1993). GDP is expected to peak at around 10.3 percent after experiencing a growth rate of 8.5 percent for 1992. GDP is also expected to top 9 percent in 1993 with current accounts forecasted to move into surplus.

Before the closure of the Panguna mine in 1989, it contributed 35 percent of export earnings and 15 percent of government revenue and accounted for about 8 percent of GDP. Loss of this source of revenue was the primary cause of PNG's economic downturn in the early 1990s. However, recent figures show that PNG's other mining ventures will continue to prosper and become increasingly more important contributors to economic development. For example, the Porgera gold mine had a total output in 1992 of 1.49 million ounces representing a 22 percent increase and making it the world's most productive gold mine outside of South Africa (EIU 1993).

While mining and oil production will be the driving force of PNG's economy during the 1990s, there has been much concern expressed at PNG's over-reliance on this sector of its economy – especially since the bulk of the revenues come from short-term projects, such as the Kutubu oil field from which production is expected to taper off in 1994. Thus, the government's newly formed development policy is premised on the need to promote a broad-based and employment-intensive pattern of growth, primarily in agriculture (Fairbairn 1992). The current aim is to develop PNG's agricultural potential for both import substitution and for export as well as to provide a stronger basis for value-added processing. Unfortunately, agricultural exports recorded a 1.7 percent decline for 1992 compared to 1991, which was itself a poor year for agriculture (EIU 1993).

Tourism is small, with only around 40,000 visitors in 1992 – representing only a 2.3 percent rise over tourist arrivals in 1991 (Keith-Reid 1993a). While such tourism levels show little prospect for significant growth in the medium term, the PNG government sees potential in the longer term. Unfortunately, there appears to be no strong commitment to tourism development with major constraints being PNG's high cost structure, infrastructural limitations, inadequate hotel facilities, and law and order problems.

Overall, however, PNG has been successful in combating the economic shocks brought about by the Bougainville crisis of 1989, and are benefiting from capitalizing on new found resources; even if not all members of PNG's society are full or equal participants in the "economic boom." The challenge now is to persevere with the task of economic restructuring to ensure that PNG's abundant human, physical and financial resources are used wisely and in ways that will sustain future growth. These projections, of course, assume that the government tackles its current political problems effectively and that production of oil and gold, the country's two most valuable exports, are not disrupted by tribal unrest (EIU 1993).

5.2 Telecommunications Developments

Since the late 1980s, PNG's government has recognized that increasing activity in mining and exploration will result in corresponding increases in telecommunications needs. The organization responsible for meeting this as well as other business, government and residential telecommunications and postal needs is the Post and Telecommunications Corporation (PTC). A statutory corporation since 1982, PTC is charged by the government to first provide affordable and quality service to as many people as possible; and second, to provide services that are financially self-supporting while returning to the PNG government annual dividends as the corporation's sole share holder (Ogden & Jussawalla 1988). Annually, since 1988, more than US$113 million in total revenue has been generated by the Telecommunications Division of PTC (Gagau & Triebell 1993).

PNG's rugged mountain terrain and widely scattered population centers have made communications between the various urban centers difficult at best. Traditionally, communications between these urban centers has been established and maintained using a combination of HF, VHF and UHF radio along with microwave and troposcatter links for different traffic requirements. HF radio telephones are used for low-grade service by rural outstations owned by government or private organizations and are manually (through an operator) connected to the national network. VHF and UHF frequencies are used to cater primarily to medium capacity systems offering a high-grade of service to subscribers usually within a coverage area of a primary exchange. The backbone of PNG's network is a series of microwave bearers providing communications to the main urban centers of population and carrying the bulk of network traffic. consisting of over 100 microwave links with solar powered repeaters on mountain tops through the rugged Owen Stanley Range, they are in many cases accessible only by helicopter (Gagau & Triebell 1993).

Due to the terrestrial nature of this network, failures within the system have been a major problem as equipment approaches

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the end of its useful lifetime and is often located in isolated areas. Failures within the microwave bearer system have been attributed to human error, equipment malfunction, lightning strikes, dead solar batteries, and – as is increasingly more often the case – vandalism by landowners demanding additional land compensation payments.

PNG is linked to the rest of the world through two modes of direct access, an undersea cable (the APNG) commissioned into service in 1979 connecting PNG with Australia, and an INTELSAT Standard B satellite earth station commissioned in 1985 (located at Port Moresby). International traffic for the APNG cable system, comprising 186 voice circuits, 1 non-voice circuit, and 12 leased circuits, is switched and designated from an exchange in Lae. In June 1990, there were a total of 88 satellite circuits, 83 voice and 5 non-voice circuits corresponding with 13 countries around the world (Mobiha 1992). Additionally, since 1987, 10 INMARSAT stations have been installed and made operational and generally serve as a standby or back-up facility for partial failures within the terrestrial network (Gagau & Triebell 1993). To improve regional connectivity with other Pacific Island nations, PNG has also very recently installed the necessary DAMA equipment on their INTELSAT earth station to allow them to interconnect with the PACT Network.

During 1990 through early 1991, PNG experienced several outages of the microwave bearer network due to acts of vandalism at one of the network's principle repeater stations which suspended telephone services to several provinces and also affecting several sites of PNG's large scale mining and oil explorations. The suspension of services to these sites meant a complete loss of vital direct telephone and data services to any outside areas and subsequently the loss of revenue. Because of this development, and since PTC was currently contemplating bids to replace the aging Standard B earth station with an new INTELSAT Standard A station as well as for the supply, delivery and installation of a domestic satellite system (DOMSAT), consideration was given to the rapid deployment of an interim DOMSAT to meet the urgent telephone, facsimile and data needs of the remote exploration sites and their main offices in Port Moresby. The INTELSAT Standard A earth station contract was awarded to Scientific-Atlanta in 1991, and they were also contracted to provide the interim and full DOMSAT system in due course (Gagau & Triebell 1993).

The interim DOMSAT system is to be composed of a 7 meter hub antenna, installed at the Gerehu earth station complex outside Port Moresby, and five 4.5 meter remote earth stations to be installed at the principle oil and mining exploration sites. The telephone, facsimile and data traffic is connected to the remote sites via a satellite link on the Indonesian PALAPA B-2P satellite. When the full DOMSAT system is installed, it will consist of 13 fixed remote earth stations located throughout PNG, and four transportable earth stations to be available for rapid deployment. The full DOMSAT system will also operate on the PALAPA satellite system, with flexibility to convert to Intelsat compliance operation in the future. The PALAPA lease will initially be for three years, after that it is anticipated that the DOMSAT system will switch to PACSTAR – an Asian Pacific regional satellite system in which PNG has a 20 percent share (Mobiha 1992).

The full DOMSAT system, when installed and commissioned, will carry a television service, 2 Mbps restorative digital carriers, and a thin-route telephony service (Gagau & Triebell 1993). The DOMSAT system is expected to be fully operational by the end of 1993 and will provide PTC with a new system of offering end-to-end communications in PNG without the problems associated with land compensation payment, vandalism or remote area maintenance.

6 Three Alternative Scenarios of Development (5)

Given the prospects for communication technology and development discussed in the above case studies, the following three scenarios take the likely course of development and role of telecommunications technology for each country and projects them approximately 30 years into the future, around the year 2020. While this is by no means an attempt to present a single model applicable to all island nations, the scenarios presented below provide a composite "sketch" drawn from the three Pacific Island country case studies and are discussed in broad brush strokes in order to take into account future possibilities for *all* Pacific Island countries. As such, these scenarios attempt to represent the common aspirations, fears and desires expressed in the previous sections and generalized for the larger Pacific Islands region.

Several factors have not been taken into consideration in the construct of these scenarios for the sake of brevity and clarity. First, the possible impact of global warming and sea level rise have not been factored into the scenarios. If the "worst case" scientific predictions are correct, within the next 30 years the smaller Pacific Island countries, such as the Cook Islands, will begin to feel the effects of these environmental conditions. This could, of course, significantly alter (if not discount all together!) the following scenarios. The results of such an environmental catastrophe would out weigh any other development concerns in the Pacific Islands and would muster global resources on a large scale towards a solution, should it eventuate, while other development concerns would pale in comparison. Despite the inconclusive evidence and ongoing scientific debate, these environmental concerns are very real and should not be discounted "out of hand" as unsubstantiated speculation. Also, rather than combine all undesirable attributes of development and technology into one decidedly negative scenario – like a "straw man," set up only to be knocked down – we have attempted to present three very "real" scenarios which, like reality, contain both positive and negative attributes and externalities. Finally, there is also the possibility of "wild card" occurrences that cannot easily be accounted for in building any scenario and are therefore ignored (e.g., global conflict, volcanic eruptions, large meteor striking the earth, etc.). What could possibly be said with reasonable certainty is that the actual outcome would most probably contain aspects of each scenario, and yet could be completely different from any of them.

6.1 Present Projected

Under this scenario, the majority of Pacific Island countries – with the exception of the larger Island countries – generally accept that they each suffer under the yoke of relative developmental limitations in terms of land area, population, and low real GDP growth rates. For some, this is a result of their remoteness from major markets, their dependence on only a few export commodities, the high cost of transport, limited economics of scale, a high dependency ratio, and the high cost of government administration. However, the respective island government's development philosophies continue to espouse a rhetoric – and to some degree a strong belief – that "self-reliance is self-respect." In many of the Pacific Island countries, government development efforts aspire to focus on marine resource development, infrastructure improvements, and – for those sites not cut-off from major airline routes – the expansion of tourism in order to solve economic and social problems as well as build national pride and unity. Unfortunately, the pursuit of some "big" development projects on the part of government (usually financed through an increasing number of international loans which may prove to be economically un-viable in hindsight) will most likely "over-mortgage" their respective country's future and will take scarce funding away from other needy sectors (mostly in productivity and social services) in order to service the burgeoning debt. For the mineral and timber resource rich countries, much of the income from such resources – it is feared – will be squandered, leaving these nations little better off than before and having to face the task of cleaning up the environmental damage. Likewise, some of the development projects initiated in the early 1990s which aimed at alleviating dependency may instead produce a cycle of more dependency. The lingering doubts about development policies that focused on World Bank and IMF type restructuring schemes – emphasizing the structural and financial side of economic development without equal focus on social and cultural issues – may prove to be unfortunately prescient, with the result that there would not been any genuine and/or equitable improvements to the standard of living in both the urban and rural areas and could contribute to an atmosphere of unfulfilled "expectation" which may precipitated increased political tension and social unrest. The standard of living will probably improve markedly for some. However, social stratification is also likely to intensify markedly and could be expected to get worse before it improves. Such an economic scenario may cause many Pacific Islanders to seek better employment and educational opportunities abroad, hoping to find a better standard of living outside their home country. Despite the anticipated difficulties expected to be experienced at the turn of the century, there is generally a feeling of guarded (hopeful?) optimism, but many feel insecure and pessimistic about the wisdom of extending the development planning and practices of the 1990s too far into the future.

Telecommunications may continue to be viewed by the respective Pacific Island governments as an adjunct to the transportation sector in its contribution to respective national development. However, having begun its restructuring in the early 1990s, the telecommunications sector in Pacific Island countries will continue to undergo a "corpratization" and – for some of the smaller island nations – consolidation process in an attempt to modernize the organizational structure and to operate domestic and international communication services more efficiently and with a view towards government gaining more direct (through share payments) and indirect (through taxes) revenue from it. Full privatization has often been mentioned as the ultimate goal. This could open the door for multinationals from Australia and the United States to take over the supply of network services in some of the larger and more lucrative markets. If this transpires, and services are offered in a "free market" environment, then the remote areas of the larger Pacific Island countries could run the risk of not being linked up at subsidized rates which may leave them off the network completely. As such, the primary concern of Pacific Island governments could most likely shift towards how best to achieve a bigger share of telecommunications revenue, while simultaneously attempting to accomplish an expansion of basic telephone services for the bulk of their respective populations. With the introduction of newer technologies such as ISDN (Integrated Services Digital Network), state monopolies in the smaller Pacific Island countries may well introduce liberalization in the supply of new services in urban areas while concentrating government resources on providing thin-route services to the rural areas. It is also possible that the growing need for Island telecommunications to comply with international standards may, on the other hand, help strengthen the state owned telecommunications corporation's position and thus stem the tide of privatization. Nevertheless, it will no doubt continue to be the policy of the respective governments that an efficiently run, corporately responsible (to make a profit for its private share holders and/or the government) telecommunications organization which can provide good quality, reliable, local and international telecommunications will have positive "spin-off effects" throughout the economy.

Since placing a relatively high priority on improving the adequacy and efficiency of the basic national network, "favorable" development loans from outside the country may continue to be sought; a strategy currently being pursued by several Pacific Island countries. However, the respective governments have also placed equal emphasis on telecommunication's social responsibility; such that, improvements to the urban infrastructure and extension of services to rural areas are seen as being of equal importance and contributing to their respective national unity. Thus, participation in a satellite network for meeting international, domestic and regional communication needs will continue to be viewed by Pacific Island countries as the most cost effective way for each to service their widely scattered populations.

6.2 *Regional Development*

"Regionalism" is nothing new in the Pacific Islands; it has been around since the founding of the South Pacific Commission (SPC) in 1947. Since about this time, regional cooperation had been, and generally is still today, accepted as an imperative for development in Pacific Island countries. This becomes even more evident when examining the conspicuous place the concept occupies in national development plans and foreign policies as well as in the rhetoric of political leaders and statesmen within the region. As a development strategy, regional cooperation is often seen as a form of "collective self-reliance" which involves cooperation among developing countries in order to promote interdependence through concrete economic actions for their common benefit or to restructure trade and/or political links with the more industrialized rim countries through the forging of new economic and political links among themselves.

As such, the South Pacific Forum (SPF) is the apex of such regional cooperation in the Pacific Islands in that representation is always at the level of head of government. There is no higher regional authority. In this scenario, while each Pacific Island nation continues to retain its independence/autonomy, participation at the head of government level through such an organization as the SPF has strengthened the multi-cultural appeal of "The Pacific Way." It is likely that, following intensive discussions among Island leaders, the old colonial hold-over, the SPC could be disbanded or its importance significantly curtailed. Likewise, a re-organized SPF (which may exclude Australia and New Zealand, but this is doubtful since none of the Pacific Island countries have the means to continue financing the organization) could emerge as a loosely confederated "Pacific Islands Community" similar to the European Community or ASEAN (Association of South-East Asian Nations). A free trade zone is created among the Pacific Island nations and steps are taken to coordinate trade policies which could lead to the formulation of the first *regional* (as apposed to national) economic development plan. National development strategies could be coordinated, through consensus decision making, such that an acceptable and successful regional division of labor is achieved. Recognizing that Australia, New Zealand, the United States, Japan, China, the European Community and the ASEAN are important trade partners – and that many of the smaller island countries produce, for the most part, the same kinds of tradable goods – multi-lateral trade agreements (such as SPARTECA) are negotiated for all sectors to insure fair and equitable benefits from trading with these rim countries. Such negotiations could become the SPF's (*a.k.a.*, the Pacific Island Community's) greatest success and spur on even further regionally coordinated developments. Through at times heroic efforts of regional coordination, the Pacific Islands Community may be able to successfully cajole the international community into action in counter-acting sea-level rise and reducing the emission of greenhouse gases as well as addressing other global environmental issues. Global technological forces would be mustered to deal with these problems and an acceptable solutions worked out.

Following global trends, the retention of a strong local and national identity becomes increasingly more important in a regionalzed Pacific Island Community and local cultures may undergo a "revival" or, come to be viewed in a new light of deeper appreciation. Traditional ways would become increasingly revered and traditional subsistence activities could also become more popular. National governments may then see it as their responsibility to nurture such activities, as traditional knowledge and practices are integrated into the education system. Because subsistence activities are viewed as important lifestyle alternatives, and not necessarily in "competition" with the monetary system, this part of the national economy could be given preferential policy consideration. The monetized sector could then become regulated – or deregulated – in such a way as to allow modest levels of growth, acceptable to local standards, and not necessarily in competition with subsistence activities.

Initially, centralized management may be seen as necessary to make the Pacific Islands Community concept work. However, as a consequence of the recently initiated development of a sophisticated regional telecommunications network and the decentralization of such institutions as the University of the South Pacific, other research and development institutes and the various programs and projects of the former regional secretariat (the SPF), it may be deemed desirable to implement a "dispersed network" in order to coordinate the operations of the emerging "post-industrial" institutions in the Pacific Islands region and, therefore, the idea of a central secretariat could be abandoned.

It is possible that the regional telecommunications network could be collectively owned and managed by a regional consortium of Pacific Islands telecommunication authorities, evolving out of the former Forum Telecommunications Program. The network could also operate as a not-for-profit corporation, all proceeds going to pay for capital improvement and equipment replacement. All staff training could be conducted in-house and on-site. In this way the region would be able to obtain, use, service, and replace in a timely manner the most up-to-date telecommunications and information technologies. The increasingly more sophisticated regional telecommunications network could evolve from the existing PACT Network (or some other yet to be implemented alternative) and would be used for both nation building within individual Pacific Island countries and the strengthening of regional ties as well as for regional news services, regional and domestic television and radio broadcasts, distance education in support of "life-long learning," and international communications.

6.3 Islands In The Information Age

The final alternative vision of development takes off from a similar recognition of each respective Pacific Island country's physical and demographic limitations (as was expressed in the other two scenarios), but outlines a course of development for Pacific Island countries which pays much closer attention to the social and physical environment (in the latter case this includes the greenhouse effect, environmental degradation, lagoon pollution, etc.) and focuses on issues of "sustainability." This course of development is seen as being less concerned with "short-run" development projects and/or stabilization problems, and instead, places more attention on the "long-run" fundamentals of development; such as resource endowments, income and trade entitlements, productivity, technological progress, social structures and institutions, and cultural preservation (Bertram 1991). Key to this course of development would be the "wise" use of a diverse range of marine resources; the promotion of indigenous agricultural production; continuation of the development (but not over-emphasis) of "flag of convenience" industries (e.g., foreign ship registry and off-shore banking) for those countries already engaged in such pursuits; and a general, region-wide "go slow, stay small" attitude towards tourism often promoted under the banner of "eco-tourism." Equality across urban and rural sectors would also be stressed for all infrastructure developments (transport, telecommunications, electricity, waste treatment, and potable water) and income distribution as a step toward lessening the disparity between urban district centers and rural outer islands. This becomes seen as a necessary measure to prevent the exacerbation of rural-urban drift. Furthermore, recognizing that the major resource in each country is the development potential of their respective populations, more funding would be put into education in order to prepare the young to cope vocationally, intellectually, and culturally as the respective Pacific Island countries increases their participation in the global economy.

In this scenario, telecommunications increasingly becomes one of the leading sectors helping to foster development – and this becomes extremely important for smaller Pacific Island countries (like the Cook Islands) which would most likely come to depend more and more on information-based industries (off-shore banking, foreign ship registry, tourism, etc.) in the employment of their population. Telecommunications could also come to be seen as a national asset and, as such, would be protected as a "natural monopoly" from foreign take-over or predatory competition. Through cross-subsidizing profits from international communications, the domestic – and particularly rural – telecommunications infrastructure could be greatly expanded. The increased penetration of primarily telephone and facsimile services into the more remote outer island areas of each country would increasingly be seen as mandatory if preferred development goals are to be met. General development projects in rural areas could be greatly speeded-up and operated more efficiently because of the improved communications links. As a result, there would be a general improvement in the living conditions in rural areas which further attracts additional project development aid. Improvements in international telecommunication connectivity could also begin to attract more local and foreign business investments in such sectors as data processing, off-shore banking and in marine fisheries as well as undersea mineral resource identification and acquisition; thus, providing jobs for an increasingly more skilled and technically sophisticated local work force. Satellite based distance education at the secondary and tertiary level, tele-medicine providing remote diagnosis of medical ailments, improvements inter-island transportation, and a general upgrading of disaster warning and preparedness would likewise provide for a higher and more equitable standard of living.

7 Conclusions

It may perhaps seem obvious from the above case studies and subsequent scenarios that the main concerns and priorities of telecommunication policy makers in the Pacific Islands differ significantly from those in highly industrialized and post-industrialized countries. Progress in establishing and expanding a telecommunications infrastructure in these three countries have been extremely difficult due to the specific conditions of theirgeographic topography, smallness of their markets, and/or the relative isolation of large segments of their population. Additionally, telecommunication network expansion in the Pacific Islands differs also in respect to each country's need to accommodate the new technological demands of their urban subscribers while attempting to provide basic services to remote communities. For all three countries of this study, the problem is attempting to create a set of institutional relations that will achieve these two objectives.

If any of the positive aspects of the above scenarios are to be realized, national telecommunication policies must attempt to achieve multiple objectives, some economic and some social. A balance must be reached so that the pursuit of one set of policy objectives does not harm the achievement of the others. Obviously, in any of the three scenarios, the highest priority for telecommunications investment must be in building up the national infrastructure. This calls for long-range visioning while seeking short-range decisions through creativity in financing and pricing such services so as not to increase the national and/or corporate debt burden. This should be possible, given that investments in telecommunications infrastructure have yielded, in the past, internal rates of return of 15 percent or more, and if the social externalities are factored into the equation, the returns are even greater (Jussawalla & Ogden 1989). Expanding user access to international teleconnectivity should become the next priority as each country seeks their "competitive advantage" in the global market of the twenty-first century.

Issues of "direct competition," which are of increasing importance in metropolitan countries, become moot in such microstates as the Cook Islands and, indeed, even in other Pacific Island countries. Given the lack of economies of scale in many Pacific Island nations, such issues really take attention away from the main task at hand; i.e., national network expansion and increased international teleconnectivity. However, policy decisions should be taken to outline the priority areas for future desired development and the respective role that telecommunications is expected to play. Then, if deemed appropriate – and in cooperation with the national telecommunication network operator – circumstances in which other suppliers could be encouraged to enter the market as a means of extending the capability and capacity of the total telecommunication system could be explored.

8 End Notes

(1) See, for instance, the work of Dommen (1980), Bertram and Watters (1985 & 1986), and most recently the special issue of *World Development* (vol. 21, No. 2, 1993) edited by Briguglio and Kaminarides focusing on "Islands and Small States: Issues and Policies."

(2) The number of persons per telephone has been argued by some scholars (along with literacy rates, infant mortality, life expectancy, population growth rates and persons per doctor) as one of a series of "quality of life" indicators for "measuring" development (*c.f.*, UNDP's *Human Development Report 1991*). When examined in the context of other developing countries, such as Cambodia with 0.08 telephones per 100 population (1,250 persons per telephone), or India with 0.68 telephones per 100 population (146.2 persons per telephone), the Pacific Islands compare quite favorably.

(3) Information contained in this section was reported earlier by Michael Ogden in a conference paper entitled, "Development and Telecommunications Technology in Pacific Island Microstates," presented at PTC'93, January 17-20, 1993, Honolulu, HI. The report draws heavily on field work conducted in the early part of 1992 and the latter part of 1991.

(4) The Cook Islands government owns all physical assets which it leases to TCI. The government also owns a 60 percent interest in the company with the remaining 40 percent owned by Telecom Networks International, a Telecom New Zealand owned corporation.

(5) The scenarios presented in this section are adapted from those developed by Michael Ogden from extensive research conducted during 1991-1992 in the Pacific Islands. The preliminary scenarios, five in total, were presented on 21 April 1993 at a Pacific Islands Studies Occasional Seminar entitled "Islands on the Net: Telecommunications Technologies and Pacific Islands Development Futures."

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TABLE 1
Constraints on Development
Demographic & Economic Indicators 1991

Country	Land area (square km)	Sea area ('000 sq. km)	Population at last census ('000)	Annual Pop. growth (%)	GNP per capita (US$)	Aid per capita 1990 (US$)
Cook Islands(p)	237	1,830	18.6 (1991)	1.07	1,958 (1986)	710
Fiji	18,272	1,290	715.4 (1986)	1.91	1,770 (1990)	62
Kiribati(p)	690	3,550	72.3 (1990)	2.07	760 (1990)	279
Nauru(p)	21	320	9.7 (1992)	2.28	9,091 (1980)	—
Niue	259	390	2.3 (1989)	-5.27	1,366 (1984)	2,800
Papua New Guinea*	462,243	3,120	3,576.0 (1990)	1.48	860 (1990)	107
Solomon Islands	27,556	1,340	285.2 (1986)	3.67	580 (1990)	136
Tokelau(p)	10	290	1.6 (1991)	-1.33	560 (1980)	2,778
Tonga	747	700	94.6 (1986)	0.49	1,010 (1990)	301
Tuvalu(p)	26	900	9.0 (1991)	2.30	430 (1985)	588
Vanuatu	12,190	680	143.0 (1989)	2.41	1,060 (1990)	335
Western Samoa(p)	2,935	120	160.0 (1991)	0.28	730 (1990)	311

Sources: NCDS, *Pacific Economic Bulletin – Statistical Annex.* Vol. 7, No 1, ANU, June 1992.
SPC, *South Pacific Economies Statistical Summary No. 13.* Noumea, 1993.
Population data compiled by SPC, *Demography Program*, Noumea, August 1992.
The World Bank, *The World Bank Atlas 1991.* Washington D.C., 1991.
OECD, *DAC Chairman's Report for 1991.* Paris, 1991.

Notes:
* Population statistics are provisional and excludes the North Solomons Province
(p) Provisional population data

TABLE 2
INTELSAT Earth Stations in the Pacific Islands

Country	Location	Type	Owner	Installation
Cook Islands	Rarotonga	Std B	TCI[1]	1980
Federated States of Micronesia (FSM)	Yap, Chuuk, Pohnpei, Kosrae	Std B (1 each)	FSMTC[2]	1983
Fiji	Wailoku	Std A	FINTEL	1975 (decom. 1987)
	Vatuwaqa	Std A[6]		1987
Kiribati	Tarawa	Std B	Kiribati Telecom	1983
Marshall Islands	Majuro, Ebeye	Std B	NTA[3]	1983
Nauru	Yaren District	Std B	Dir. of Telecoms	1975
Niue	Alofi	Std D1	Post & Telecoms	1989
Papua New Guinea	Port Moresby	Std B	PTC[4]	1985
		Std A		1991 (contracted)
Solomon Islands	Honiara	Std B	STCL[5]	1975
Tonga	Nuku'alofa	Std B	Cable & Wireless	1975
Tuvalu	Funafuti	Std D1	Telecoms Dept.	1990
Vanuatu	Port Vila	Std B	VANITEL	1979
Western Samoa	Afiamalu	Std B	Post & Telecoms	1980 (decom. 1991)
	Maluafou	Std A[6]		1991

Source: South Pacific Forum (1991). Regional Telecommunications Report.

Notes:

1 Telecom Cook Islands Ltd. (TCI), formerly Cook Islands Telecommunications Corp., took over the operation of the international gateway from Cable & Wireless in 1991.

2 In 1988, the FSM Telecommunications Corp. (FSMTC) purchased each of the four earth stations originally installed and operated by Comsat.

3 The National Telecommunications Authority (NTA) of the Marshall Islands purchased the two Comsat earth stations in 1987.

4 Post and Telecommunications Corporation (PTC), recently awarded Scientific-Atlanta a contract to build, install and commission a new Standard A earth station to replace aging Standard B earth station currently in use.

5 Solomon Telekom Company Ltd. (STCL), joint venture between Cable & Wireless and Solomon Islands government.

6 New 15 meter INTELSAT Standard A earth station antenna.

TABLE 3
Pacific Islands Telephones 1990

Country	Total Telephones	Total Population	Telephones per 100 Pop.	Telephone Wait List (est.)	Government Operation (%)	Private Operation (%)
Cook Islands	2,540	18,552	13.7	245	60	40
Federated States of Micronesia (FSM)	2,400	112,000	2.1	700	100[1]	0
Fiji	68,532	726,000	9.4	11,500	100[1]	0
Kiribati	1,130	68,828	1.6	133	100[2]	0
Marshall Islands	1,193	42,108	2.8	1,500	25[3]	75
Nauru	1,600	9,053	17.7	160	100	0
Niue	390	2,267	17.2	—	100	0
Papua New Guinea	73,068	3,600,000	2.0	1,491	100[4]	0
Solomon Islands	5,976	329,000	1.8	130	60	40
Tonga	3,984	95,810	4.2	680	100[1]	0
Tuvalu	150	8,624	1.7	60	100	0
Vanuatu	6,480	159,830	4.1	88	51	49
Western Samoa	4,335	181,984	2.4	2,600	100	0

Source: South Pacific Forum (1991). Regional Telecommunications Report.

Notes:

1 In these countries the telecommunications authorities have been "corporatized" to operate as state owned enterprises and are seen by the respective governments as a step in the process of eventual privatization.

2 Whereas the government of Kiribati owns all domestic and international telecommunications assets, the government has entered into a joint venture with OTCI of Australia to manage all public switched telecommunications in the country.

3 Following the public sale of shares in the Marshall Islands National Telecommunications Authority in December 1991, the government of the Marshall Islands holds 25% and controls the balance of unsold shares.

4 The government of PNG owns all shares in the Post and Telecommunications Corporation (an independent body since 1982) and appoints all eight members of its Board of Directors.

SUBMARINE SYSTEM TECHNOLOGY OF THE FUTURE

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ABSTRACT:

Beginning with the first deployment of submarine fiber-optic systems in the late-80's, the evolution of submarine fiber-optic technology in terms of capacity, capability, reliability, and technological advancement has been exponential. Projecting beyond the initial amplifier system offerings, we envision systems with even greater capacities, utilizing new transmission schemes such as solitons and wavelength-division multiplexing. Additionally, new technologies, not only for undersea equipment, but also for terminal equipment, will be developed over the next decade to support even more reliable and flexible undersea system architectures. This paper will briefly review the historical accomplishments of the submarine fiber-optic technology and project its future evolution.

SUMMARY:

Beginning with the first deployment of submarine fiber-optic systems in the late-80's, the evolution of submarine fiber-optic technology in terms of capacity, capability, reliability, and technological advancement has been exponential. The first generation systems provided a twenty-thousand voice circuit capacity per fiber pair connecting two landing points and utilized NRZ-modulated multi-frequency 1.3 micron lasers in regenerative repeaters. Repeater spacing was less than 100 km and systems were designed with multiple levels of redundancy to ensure reliability.

Second generation systems, deployed initially in 1991, double this capacity and provide the capability to multiplex signals underneath the ocean and route them to different landing points. Second generation repeaters utilize 1.5 micron single frequency lasers, are spaced at nearly 150 km., and are typically installed with only one level of redundancy to achieve the same reliability as the first generation systems.

Third generation systems, scheduled for first installation in 1994, will multiply the capacities to over three-hundred thousand voice circuits per fiber pair. These systems can be designed to operate in various configurations, one of which is a ring network. This innovative configuration is self-protecting and can ensure that calls will not be dropped during any single undersea system failure. The optical-amplifier repeater designs will be even more robust than their regenerative counterparts. These newest generation systems will be "all photonic" in that no electronics will exist in their transmission paths.

Projecting beyond the initial amplifier system offerings, we envision systems with even greater capacities, utilizing new transmission schemes such as solitons and wavelength-division multiplexing. Additionally, new technologies, not only for undersea equipment, but also for terminal equipment, will be developed over the next decade to support even more reliable and flexible undersea system architectures. These new technical and architectural capabilities will revolutionize the global network as well as the developing regional networks and enable modern communications facilities to be extended ever more fully to developing countries. These developments, in turn, will open new horizons for new and innovative service offerings that will, themselves, support and encourage the development of both regional and global markets and encourage progress toward a truly global economy.

This paper will briefly review the historical accomplishments of the submarine fiber-optic technology and project its future evolution.

1. INITIAL SYSTEMS

The first transoceanic telephone cable system, TAT1 (Trans-Atlantic Telephone 1) was laid in the early 1950's. Before that time all transoceanic telephony had to be handled by radio. TAT1 and next 6 transatlantic cable systems were all analog and used undersea coaxial cable. The first digital optic system, TAT8, was placed into service in 1988 between Britain, France, and the USA and used a new type of submarine cable containing three optical fiber pairs. The then new SL cable is shown Figure 1.

This development was followed quickly by TPC3 (Trans-Pacific Cable 3) and HAW4 (Hawaii 4) which provided service between Japan, Guam, and the USA. The quality of service provided by these new systems signaled the beginning of a revolution in capacity growth both in the Atlantic and in the Pacific regions.

These initial optical systems operated at 140 or 280 Mb/s. They used multifrequency lasers at 1.3 microns and had repeater spacing of less than 100 km. Depending on the system bit-rate, they support ten or twenty thousand voice circuits per fiber pair.

These first systems formed a backbone network between the developed economics in both the Atlantic and Pacific regions. Following quickly on the deployment of these main systems, initial network extensions were made to developing economics in the Atlantic, Pacific, and Caribbean regions.

In all, AT&T installed or has participated in the installation of ten 140/280 systems. This required the laying of some of 30,000 km of cable and required 420 repeaters.

2. SECOND GENERATION SYSTEMS

Second generation digital optical systems doubled the line rate of the first generation systems to 560 Mb/s, or up to 40 thousand voice circuits per fiber pair, and introduced new features such as the Undersea Branching Multiplexer (UBM). UBM's allow traffic being carried on one fiber pair to be transferred to another fiber pair in route. This enabled the construction of TAT9 that provides connectivity between Canada, Britain, France, Spain, and the USA.

In addition to TAT9, two more 560 systems have been installed in the North Atlantic and another system will soon be installed along the Columbus route between the Caribbean region and Spain, Portugal, and Italy. These new installations have provided a virtual revolutionary increase the transmission capacity in the Atlantic region as compared to the first generation systems.

New 560 systems have also been installed across the Pacific. These are TPC4 and HAW5. In addition, 560 systems have also been installed or are being planned for other parts of the Asian-Pacific region. These will similarly provide a revolutionary increase in the traffic capacity of that region of the world as well.

A summary of 560 systems that have been deployed or are now being planned to interconnect developing areas of the world includes a system between the Caribbean and South America and one internal to South America, several systems in South East Asia and the Pacific Rim, several systems in the Mediterranean, and one from the Mediterranean through the Red Sea, the Indian Ocean, and into the Pacific to encircle the globe. Figure 2 shows the current and planned coverage of the worldwide undersea network.

The 560 systems operate at 1.5 microns, use single frequency lasers, and have a maximum repeater span of 150 km. To date, AT&T has installed or has participated in the installation of eleven 560 systems with 45,000 km of cable and over 300 repeaters. It is significant to note that even though the total length of the 560 installations is 50 percent greater than the total length of the 140/280 installations, the total number of repeaters is about 30 percent less.

3. THIRD GENERATION SYSTEMS

The development of the optical amplifier has opened two new fronts for future system development. These are:

1. Long haul repeatered systems with bit-rates of 5 Gb/s and higher

   This bit-rate is an order of magnitude higher than the 560 Mb/s of second generation systems and represents another leap in system capacity.

2. Repeaterless systems with lengths up to 300 km and more with bit-rates of 622 Mb/s and higher.

   This will make it possible to economically meet the communications needs of developing economies.

Another feature of amplifier systems (both repeatered and repeaterless) is that they can be upgraded without replacement of the undersea plant if they have been engineered to provide for this capability. That is, repeatered amplifier systems may be upgraded to a higher bit-rates by simply changing the terminal equipment if the repeater spacing will support the new bit-rate. Similarly, repeaterless systems can be upgraded to higher bit-rates if the available power in the terminal equipment will support the new bit-rate. This results from the fact that optical amplifiers themselves are bit-rate insensitive.

3.1 Repeatered Amplifier Systems

The bit-rate performance of repeatered amplifier systems is nearly an order of magnitude higher than can be achieved in regenerative systems. This is true even for system lengths in excess of 10,000 km as shown in Figure 3. This has been verified by circulating loop experiments as shown in Figure 4 and also in full system simulations whereas many as 274 amplifiers have been tested in series. At this bit-rate, as many as 350 thousand voice circuits can be carried on a single fiber pair.

The reliability of amplifier repeaters is also revolutionary when compared to the reliability of regenerative repeaters. All components in amplifier repeaters are either passively redundant or passive in nature. No "high-speed" electronics are used. The most complicated electronic sub-system in an amplifier repeater is the power-supply.

Amplifier systems can also be designed to be very resilient to local changes in signal level. Typically, optical amplifiers in systems operate with about 2 dB of distortionless gain compression. Thus, if the signal level falls due to a drop in pump drive or an increase in system loss due to a repair, for example, the signal returns to its normal level within a few repeater spans. Since the signal at an amplifier input is designed to be well above the noise level, the signal-to-noise ratio of the entire system is largely unaffected by such local signal level changes. Since these systems are analog, total system noise is a function of system length. Therefore, repeater span lengths are dependent on the system length with 77 km spacing used for short systems and proportionately shorter span lengths for longer systems.

Another important feature is that system line performance can be monitored from the terminal station in a totally passive fashion using OTDR techniques. To do this a very low level signal is modulated onto the carrier. At each repeater the signal is "looped back" through a special "high loss optical loop back" coupler. The terminal can then determine the gain performance of each individual amplifier in the system by recovering this low level signal as returned by each successive repeater and comparing the various levels.

The first two long haul repeatered amplifier systems, Americas-1 North and Columbus-II Segment B, will be installed in 1994. Both of these will be laid in the Caribbean, be roughly 2000 km in length, and have bit-rates of 2.5 Gb/s with two fiber pairs in each system.

The first two transoceanic amplifier systems, TAT12/13 and TPC5, will operate at 5 Gb/s and will use ring network technology, as is shown in Figure 2, to insure that service will not be lost even if a fault occurs. Both of these systems will be installed in the 1995/96 time frame.

3.2 Repeaterless Systems

New repeaterless system capabilities depend on a combination of high signal power and low loss fiber. Each of these will be discussed below.

Terminals generally employ laser diodes as optical signal sources. These usually operate at power levels of no more than 1 or 2 dBm and redundancy schemes often reduce the available power level even more. To obtain sufficient power for long distance transmission from such a terminal, an optical amplifier can be used to amplify the signal level. These amplifiers can be installed as part of the terminal or as ancillary equipment in the terminal station. These units are called Fiber Amplifier Booster Modules (FABM) or Line Terminating Units (LTU).

To increase transmission distance even more, FABM's can also be equipped with detectors and additional transmitter elements to allow shifting of the signal wavelength from 1.3 microns to the more desirable 1.5 micron band for transmission and back again to 1.3 microns again for detection at the remote terminal. This is shown in Figure 5.

New low loss fiber is also being developed for these applications. This fiber features a pure silica core and has an average loss of as low as 0.180 dB/km. In addition, since repairs do not require the handling of repeaters, a family of new and economical lightweight cables has also been developed for repeaterless systems. This cable is shown in Figure 1. These new cables are not only more cost effective themselves, but more importantly, they lend themselves to new and more cost effective means of deployment.

A repeaterless system between Cypress and Israel (CIOS) has recently been installed. It is operating at 622 Mb/s and is 262 km in length. Other repeaterless systems are being planned with similar or even better performance characteristics. Examples of these are an extension to the Americas-1 South system, an inter-island system proposed for Hawaii, and a coastal festooned system being planned for South America.

4. NEW NETWORK INTERFACE CAPABILITY

Terminals for amplifier systems have been designed to not only accept PDH (CEPT-4) tributaries but also the new CCITT defined SDH (STM-1) tributaries as well. In addition, the new systems can even accommodate a mix of PDH and SDH signals on a single fiber pair.

The CCITT transmission rates are 622 Mb/s (STM-4) and 2.5 Gb/s (STM-16). 5 Gb/s transmission is accomplished by multiplexing two STM-16 signals together. There are interface cards designed to accept both PDH (CEPT-4) and SDH (STM-1) signals. The change is made either by an option switch or by software control. This will allow an orderly migration from the current PDH world to the SDH standardized world planned for the future.

5. NEW NETWORK ARCHITECTURES

On a global basis, developing countries are structuring or restructuring themselves by privatization, economic liberalization, and the development of free markets to promote growth. For significant growth to take place in a region, a communications infrastructure must also be present.

Network architecture capabilities available in the regenerative systems made it possible to implement star and branched star types of networks as in TAT-8 and TAT-9. The APC system is an example of festooning or multi-drop in a coastal region. However, powering limitations make this difficult.

Today, technological capabilities such as flexible network architectures available with amplifier systems, network protection equipment capable of reconfiguring network transmission paths without dropping calls, and add/drop multiplexers make it possible to tailor systems to fit local needs in the area of capacity, reliability, fault tolerance, restoration, upgradability, and national sovereignty. These new architectures make it possible to meet the communications needs of an area at any stage of economic and telecommunications development.

Examples of various network configurations as shown in Figure 6, are described below:

A. Star:

The Star network architecture consists of a hub station, with cables branching from this hub to the various required landing points via separate cables. In this basic star configuration, no nation's traffic is required to pass through another nation on its way from the hub. In other words, this configuration optimally meets the requirement of preserving national sovereignty. It requires only one cable landing point terminal, which represents an economic saving. However, it also requires a separate cable for each nation. It is relatively costly, therefore, when nations are far apart geographically.

B. Branched Star:

The Branched Star architecture provides the same capability of the basic Star, except the splitting of the traffic is done undersea, minimizing the cost of separate cables between remotely located landing points. This is accomplished with a branching unit, which is conceptually similar to a cable joint that interconnects the fibers of a single trunk cable to separate fibers within various branches. In the future, it may be feasible to provide a branching unit with wavelength splitting to allow WDM channels to be split between various branches of a branched system from a single trunk fiber.

C. Trunk and Branch:

The Trunk and Branch network connects several countries to a single trunk cable via branching units. The trunk technology is based on optical amplifiers, and the hub/node equipment on SDH products, to allow maximum flexibility in growth and reconfiguration. Branches may be relatively short and non-repeatered for simplicity of interconnection.

D. Coastal Festoon:

Not shown in the figure is the festoon architecture, which is an increasingly popular alternative to a land based system, especially when the continental terrain provides difficult installation and maintenance challenges. The festoon architecture is basically a series of coastal loops between major coastal cities and is often, though not always, deployed with the somewhat more affordable repeaterless systems. These repeaterless applications are also often engineered with higher fiber count cables than required at the start of life, in anticipation of future increased capacity requirements; thus the future cost of marine installation of a new supplemental system with more capacity is avoided. The architecture of such systems often mirrors those of typical land-based systems, and may often be used as a supplemental diverse route to an existing land based system.

E. Ring:

The Ring architecture has been designed predominately to address the issue of automatic restoration even in the event of a cable failure. This configuration is basically a set of point-to-point cables, with twice the requisite transmission capacity, connected together in a ring configuration. In the case of any single cable failure, such as a cable cut within the ring, the traffic gets routed around the ring on the spare capacity, away from the inoperable segment, and on to its original destination. The shore based SDH transmission equipment provides the automatic failure detection and switchover control for the entire ring without dropping a call. During the periods where the full cable system is in operation, the reserve capacity can be put into service on a preemptible basis. It is important to reiterate that as a result of the reliability of undersea cables, the probability of interruption of even this part-time traffic is extremely low. Ring systems such as this are being deployed across the Atlantic and Pacific in the 1994 to 1996 time frame. The standards governing the transmission equipment, such as Add/Drop multiplexers (ADMs) or Network Protection Equipment (NPE), are now being studied for undersea applications by CCITT. Thus the ring network provides the restoration capabilities required of regional system customers described earlier.

F. Branched Ring:

The Branched Ring architecture extends the basic capability of the ring with the addition of a branching unit. This structure retains the self-healing nature of the ring, but provides independent connections to the hub and requires only a single landing per terminal. The branched ring, then, can be thought of as a merger between the branched star and the ring, retaining most of the good features of each. In fact, the primary difference between a branched star and branched ring is the single connection that closes the ring. Such a connection can be made in a number of ways, including connection through other networks.

With proper planning, a network can be installed as a branched star configuration or trunk and branch arrangement and upgraded later to a branched ring as other networks or point-to-point systems are built.

Several potential architectures for regional and domestic systems, each optimizing different parameters, such as restoration or flexibility, have been described above. Choosing the best architecture for a specific application should be done not only on the present traffic needs, but also on the future anticipated needs. The flexibility of the system technologies offers the opportunity, via upgrade, to modify the original system network architecture during the system's life, prolonging the useful life of the system.

6. CONCLUSIONS

6.1 Costs:

The cost of undersea cable systems is becoming increasing affordable. Although repeatered system costs have not changed significantly over the past decade, "per circuit costs" have decreased dramatically with the staggering increase in capacity of cable systems, putting the per circuit undersea cost on par with the per circuit cost of a land based system. A transoceanic cable system can cost hundreds of millions of dollars and shorter repeatered systems can cost upwards of many tens of millions dollars, but transmission capacity per fiber and the number of fibers per cable have decreased the per circuit cost by four orders of magnitude. The lower cost repeaterless systems can now meet the needs of expanding customer applications, which in the past may have required a repeatered solution. As mentioned above, appropriate engineering of the new systems from the outset can also minimize the future costs of upgrades to higher capacity.

In addition, new financing strategies are now being considered by various suppliers to allow the first cost to various customers to be minimized. The Build/Operate/Transfer (BOT) technique has been used in some areas of the world to make the initial procurement of a system more affordable. The flexibility of the new amplifier based systems, which allow a network to expand over time, in terms of capacity and landing points, also works toward managing the customer's investment in transmission facilities more effectively.

6.2 Technology Enhancements:

There are many things that can still be done to improve this picture and make the transmission of voice, data, text, and video even more error free, inexpensive and universally available. Some of the areas currently being investigated and/or incorporated into products are described below:

1. Forward Error Correction.

   Forward Error Correction (FEC) can be used to extend the span length in a planned repeaterless system or allow an existing system to accommodate higher bit-rates. For a repeatered system FEC can be used to provide virtually error free performance or an increase in the system bit-rate. Application of FEC is a terminal function and has no impact on the submarine plant.

2. Remote Pumping:

   Remote pumping involves the pumping from the terminal station of an Erbium Doped Fiber Amplifier (EDFA) located in an undersea cable at some distance from the shore. This helps to increase the span length and bit-rate limits in repeaterless systems without introducing the need to power and monitor an undersea repeater.

3. Optical amplifier "front ends" for optical receivers:

   This can improve the sensitivity level of optical receivers and directly effect system margins, bit-rate limits, and system lengths.

4. Wavelength Division Multiplexing:

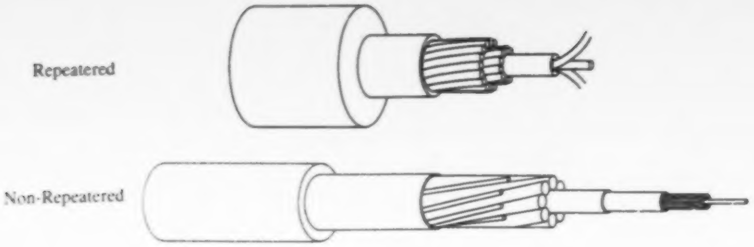
   Wavelength Division Multiplexing (WDM) will make it possible to transmit more than one active signal on a fiber pair. Since both the EDFA and fiber bandwidths will easily accommodate several simultaneous optical signals, it is reasonable to expect to see this capability being used in future optical systems just as FDM was used in radio systems.

5. Soliton Transmission:

   The use of solitons will eliminate the need to use NRZ modulation and should allow systems to operate from 10 to 20 Gb/s for a single signal. In addition, they greatly facilitate the use of WDM technology. These technologies (solitons and WDM), when taken together can create another order of magnitude revolution in the capacity of optical fiber pairs.

6.3 Summary:

Global telecommunications connectivity has become a prerequisite to successful competition in the global marketplace. This paper has discussed ways in which new undersea cable system technologies can meet these needs. With appropriate partnering of government and industry, global connectivity is possible in the not too distant future. The common technologies utilized in both undersea and land based systems provide the necessary platform to create a seamless network combining these two types of facilities. AT&T, with its experience in undersea cable system technology and network design is ready to lead in making the global telecommunications vision a reality, and thereby enable a truly global economy.


Repeatered
Non-Repeatered

Fiber Optic Submarine Cable
Figure 1

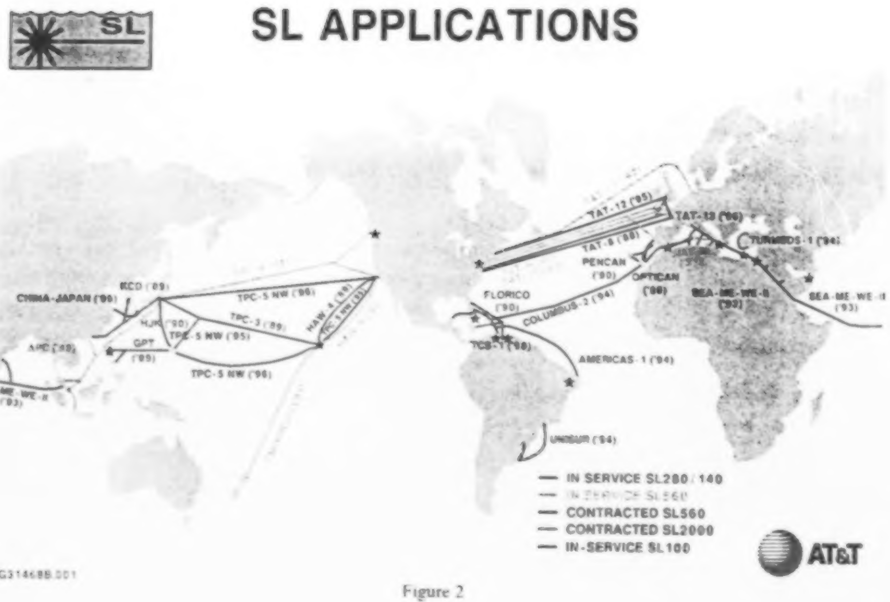
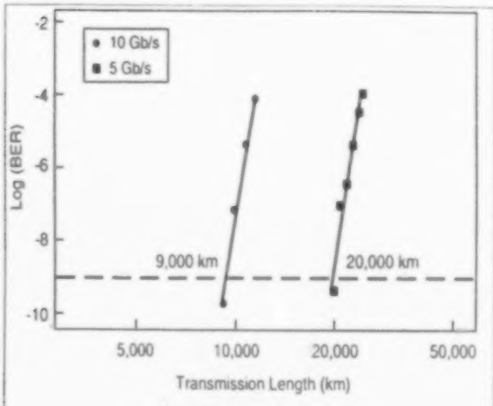
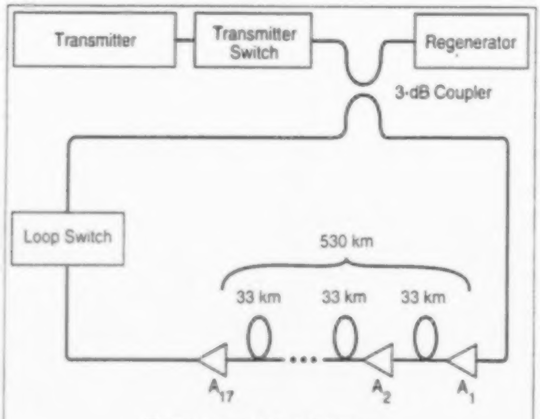

SL
SL APPLICATIONS
CHINA-JAPAN ('99)
KCD ('89)
TPC-5 NW ('96)
TPC-3 ('89)
HJK ('90)
TPC-5 NW ('95)
HAW-4 ('89)
TPC-5 NW ('95)
APC ('93)
GPT ('89)
TPC-5 NW ('96)
SEA-ME-WE-II ('93)
TAT-12 ('95)
TAT-13 ('96)
TAT-8 ('88)
PENCAN ('90)
OPTICAN ('90)
TURMEDS-1 ('94)
SEA-ME-WE-II ('93)
SEA-ME-WE-II ('93)
FLORICO ('90)
COLUMBUS-2 ('94)
TCS-1 ('90)
AMERICAS-1 ('94)
UNISUR ('94)
IN SERVICE SL280/140
IN SERVICE SL560
CONTRACTED SL560
CONTRACTED SL2000
IN-SERVICE SL100
AT&T
HG31468B.001

Figure 2



Error Rate vs. Length
Figure 3


Transmitter
Transmitter Switch
Regenerator
3-dB Coupler
Loop Switch
530 km
33 km
33 km
33 km
A_{17}
A_2
A_1

EDFA Loop Block Diagram
Figure 4

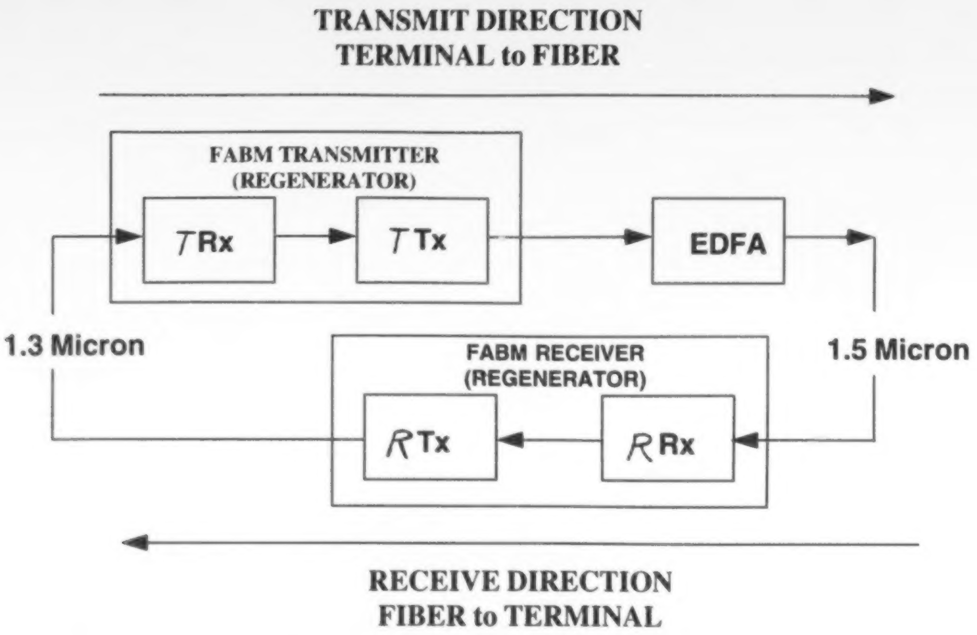
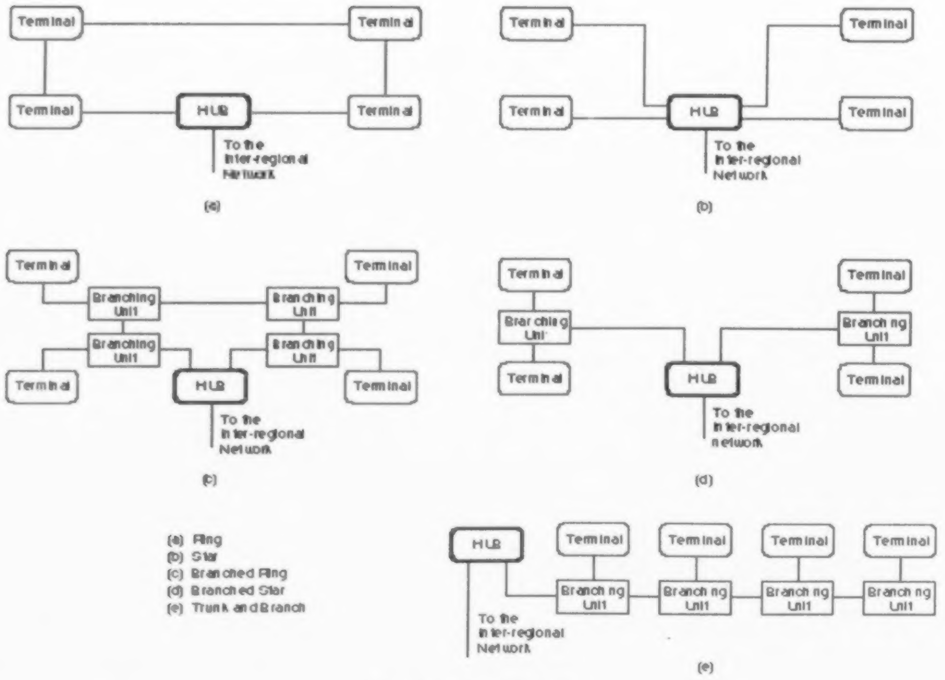

TRANSMIT DIRECTION
TERMINAL to FIBER
FABM TRANSMITTER
(REGENERATOR)
TRx
TTx
EDFA
1.3 Micron
1.5 Micron
FABM RECEIVER
(REGENERATOR)
RTx
RRx
RECEIVE DIRECTION
FIBER to TERMINAL

Figure 5. Simplified Block Diagram of the FABM


Terminal
HUB
To the Inter-regional Network
(a)
(b)
Branching Unit
(c)
(d)
(e)
(a) Ring
(b) Star
(c) Branched Ring
(d) Branched Star
(e) Trunk and Branch

Basic Network Typologies
Figure 6

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Cable Network Procurement in 2000 and Beyond

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1 INTRODUCTION

Ownership of submarine cables has traditionally rested in the carriers to whose networks they have belonged. During the whole of the analogue era the pattern was unchanged: international traffic was the responsibility of national PTTs who had a monopoly of international traffic originating and terminating in their territory. Submarine cables were almost invariably international links and their ownership was vested in the carriers who required capacity between the (two) landing countries as part of their international network. Therefore the pattern was established whereby the regional CCITT planning meetings identified a requirement for a cable. This was followed by a number of data gathering meetings leading to a Memorandum of Understanding, a procurement process, a Construction and Maintenance Agreement and a supply contract for a system. The carriers whose needs the cable met became the owners of the system.

2 THE ERA OF FIBRE OPTICS AND PRIVATISATION

The advent of the optical era did not initially see any change in this pattern: indeed there was no reason why it should. However the start of the optical era in submarine cables coincided with the beginning of a fundamental change in the structure of the telecommunications industry. The digital age, the age of information technology, was dawning, and this new age needed to harness the computer to the telecommunications network to achieve its potential. In parallel a significant change of attitude to the role of the state in the economy began to develop in Western Europe leading to many countries deciding to pass the ownership of state owned industry into the private sector and open monopolies (state and private) to competition. The telecommunications industry has been at the forefront of this trend. It was generally believed that the new age was more likely to develop quickly in a private capital/free market environment and therefore it became a natural target for privatisation and deregulation. Although this began as very much a Western European phenomenon, re-inforced by the free market principles enshrined in the European Community, it matched the already established position of the FCC in the USA where AT&T's long lines monopoly had been broken, followed by the divestiture of the RBOCs. More interestingly it has also been taken up to a greater or lesser extent throughout the rest of the world even in countries where there is no obvious desire to roll back the frontiers of the State generally. Reasons for this have varied from country to country, but in as far as there is a general theme it is the recognition that the development of the telecommunications network is fundamental to economic development and this can be achieved more quickly if private capital can be channelled into the development of both the basic infrastructure and the services available to business and to individuals. The implications of these developments on the structure and procurement of submarine cable systems will be dramatic. The first effects stem from the willingness of governments to allow international traffic to be opened up to competition.

Specifically the willingness of the FCC in the USA and the British government in the UK to allow a private cable to be landed in their territories led the way to PTAT, the first private transatlantic cable system, in which Cable and Wireless was the major owner. Liberalisation also led to Japan opening up its international traffic to competition, and the North Pacific Cable was laid from Japan to the West Coast of the USA with IDC of Japan joining C&W as the major owner.

These first private systems represented a new stage in the financing and ownership of international submarine cables. Nevertheless, they were still financed and built by carriers of international traffic with the sponsors holding capacity for their own use and selling capacity to other carriers on the traditional IRU basis. Construction and Maintenance Agreements were signed in a similar way to PTT sponsored systems.

3 CABLE SYSTEM AND THE PRIVATISED CARRIER

In trying to predict the pattern which will develop in the future, it is necessary to draw together all the influences to change which are operating. In many countries PTTs are losing their monopolies and also being privatised. In the short term these may be conflicting aims, as the short-term profitability of a company will be higher if it holds a monopoly, and therefore the privatisation proceeds will be greater for the selling government. On the other hand the pressure to limit monopolies is very strong, and likely to be paramount in the longer term. We are therefore seeing increasingly carriers who are highly competitive, operating alone or in partnership on a global basis and with a need to offer a financial performance which will make them desirable to the stock markets of the world. The first stage of the analysis is therefore to examine how this change in identity will affect the behaviour of these companies. Already there are enough examples for a pattern to be established, and we can have confidence in the model being developed on two counts. Firstly it is a logical model. Secondly, corporate advisors and planners tend to follow current fashions.

The model starts by being "customer focused". The organisation is structured in a way which allows it to address its customers as effectively as possible. This tends to lead to profit centres being established based not on the services being offered but on specific customers, or on customer types. However at the operating level there is a basic need to ship bits (for this structure is one for the digital age) around a network, and to this network a bit is a bit is a bit. As the network is effectively blind to the services that it is carrying, two consequences flow. Firstly, the network becomes a common service to the organisation. Secondly, it tends to be seen as a cost centre rather than a profit centre. These facts become of crucial importance when resources, particularly capital, are to be allocated. By definition the profit centres, where the competitive battle is being fought, will have a higher claim. This is not to say that the network will be neglected, for without a high-quality network the advanced services mean nothing.

But with the growing availability of all digital networks operating synchronous hierarchies, the scope to gain an advantage over the competition by a better network will be limited. The network function will be asked, therefore, to provide the standard (ie very high quality) service as economically as possible. It should be noted that this may not necessarily be the cheapest in terms of a strict economic analysis. The profit centres will expect to have capacity available on demand, the finance director will want to see the lowest possible cash outflow. Under these pressures it is not too difficult to imagine a manager of network operations whose dream is to be able to obtain capacity ex stock if such a thing were available. It is the hypothesis of this paper that given the demand, something will materialise to fulfil the dream.

4 THE OWNERSHIP OF CARRIER'S CARRIER SYSTEM

The author's belief is that "carrier's carrier" systems will gradually become the norm. These systems will exist as entities separate from traditional PTT's, or privatised carriers. They will be largely financed by non-telecommunications institutions who will be investing in anticipation of a good return. This will not be an instantaneous change, and carriers will continue to exercise a considerable interest in them. For the carrier the opportunity is to be able to minimise his investment in network facilities to free up capital to invest in the maintenance of his competitiveness and the development of his business. This can only be achieved if the quality of his network is maintained, and it seems highly unlikely that in the near future a carrier will be willing to relinquish any influence in either the technical aspects of the systems he uses or the provisions for the maintenance of those systems.

At the same time it seems highly likely that the suppliers will become involved in the ownership of these "carriers' carrier" systems. From one side the suppliers will wish to participate to try to secure a favoured position in the award of the supply contracts; from the other side the other participants will be looking for both an element of supplier finance and (in respect of investors external to the industry) a technical input in what will continue to be a rapidly evolving technology. Within this structure there will be a need to refine the mechanisms which already exist to ensure that supply contracts are fairly priced.

The structure postulated will in fact have implications for the rate of change in technology. When one considers the rate of change of technology in the analogue era, the rate of change in technology in the optical era is staggering. It is less than six years since the second international optical cable went into the water, and we have seen four generations of regenerative systems and this year will see the first international optically amplified systems in service. It could be argued that this has been driven by the demand for bandwidth; having said that, no system has been constructed which utilised the full potential capacity of the system design in the sense that all first generation deep water cables were designed for twelve fibres and no regenerative repeater housing handles more than eight repeaters, whilst interleaving of repeaters has hardly ever been used.

With the increasing R&D cost of each new generation or technology, and the advent of a financially more rigorous view of investment, the trend in technology will be towards the expansion of system capacities by the use of more fibres and a slower rate of introduction of new technologies.

5 SYSTEM MAINTENANCE

Progress towards this changed world will be evolutionary. Initially it will be on a system by system basis, but this immediately leads to the issues of maintenance and restoration. The present structure of cable maintenance agreements is likely to change in the next few years in any case as traditional vessels become more expensive and new approaches to installation and maintenance evolve. Equally, as carriers come to regard international bandwidth as a warehouseable commodity, the suppliers of that commodity will be expected to offer it on a guaranteed basis. In other words to meet the demand of their customers they will have to provide both for the maintenance of their systems and their restoration.

This has two consequences: the system suppliers will have to offer maintained systems, and they are likely to develop into suppliers of networks rather than individual systems. In respect of maintenance there is a further pressure: if major carriers are willing to use a warehouse facility for the provision of network capacity they are highly unlikely to continue to buy ships.

A further stage in this development which we can envisage is the involvement of the new generation carriers' carrier in satellites. The paper began by examining the pattern of international cable networks in the future, but the hypothesis is of warehoused bandwidth. The logical conclusion has to be that the bandwidth supplier offers what its customer wants, which will be available, reliable, high-quality bandwidth at minimum cost. The bandwidth suppliers will therefore take the same approach to the media used as they will take to the transmission technology; what is the most profitable way of meeting the customers need. The cable versus satellite debate will revolve around the usual issues of cost, quality of circuits and route diversity. Where these dictate satellite, then it will be chosen.

6 THE PACIFIC REGION AND THE NEW ERA

To an audience such as this there is the particular question as to the effect it will have on operators in the Pacific Region. At the first level it is likely to mean that a system of stocked circuits in international systems will develop. Operators will not need to invest in circuits at the planning stage of a system. To the smaller operators this will allow far greater flexibility than in the past and this is likely to be of particular importance to areas with small populations and a limited demand for international circuits. Admittedly this argument applies to the larger carriers as well, but their larger scale of operation by definition implies both the need and the availability of resource to do more long-term detailed planning. What does seem likely is that there will be more opportunities for the introduction of cable systems on routes that at present do not look likely to happen. If a cable system can be seen to be in the long term a viable proposition, then in the environment that I have described such systems are more likely to be implemented. If the prospects for the growth in traffic over the route are extended, the system still has a chance of being implemented. If growth is expected to be slow, the system will be more expensive, as it will have to bear a higher financing cost, but for many places in the Pacific a more expensive system will be much better than no system at all.

This paper has presented a very radical view of the world and one which at first sight may seem unlikely. However, I suggest that many of the signs are already there in respect of the changing organisations introduced by, for example AT&T, Ameritech and BT. Likewise the battle which has now opened for the major carriers to establish themselves as global suppliers will put increasing pressure on balance sheets which are scrutinised not by governments but by the financial markets of the world. The future is closer than you think!

Networking trends in submarine cable systems

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1 INTRODUCTION

Submarine cable systems have been around for longer than the telephone with the first telegraph submarine cables having been deployed in the 1860s. Such cables were invariably point-to-point cable systems connecting two major economic regions. The point-to-point nature of cable systems remained even when they were used for telephony; and from the 1950s onwards these systems began to grow significantly in both size and importance. The technology used for these early systems was analogue transmission using frequency division multiplex principles. But still the systems were installed as just point-to-point arrangements.

The advent of optical fibre technology using digital transmission and its application to submarine cable systems in the mid-1980s represented a quantum leap in terms of performance and quality of transmission. However, it has only been in the last few years that the idea of installing a submarine cable system that is anything other than a point-to-point system has been turned into reality.

This paper discusses this relatively new trend in the networking design of submarine cable systems and highlights in particular the relative benefits of the different options in terms of traffic connectivity, economics and technical complexity.

2 WHY HAVE ANYTHING OTHER THAN POINT-TO-POINT SYSTEMS?

Point-to-point systems met the requirements of telecommunications operators for many years, in fact many decades. So why has there been any change to this status quo?

In fact there are a number of reasons and these are discussed below.

2.1 POLITICAL

Traditional operators originally installed point-to-point systems using the premise that traffic at either end of the link would be sucked in from other countries via tree networks provisioned separately. Whilst this approach proved acceptable for many years, the growth in international traffic and competition between operators was such that eventually new (to the submarine systems network arena) operator entrants in other countries wanted to have direct access to the cable systems.

The political solution that was found was the provision of underwater branching units which permitted the cable to be split and facilitated the provision of two, or more, landing points. The first major example was TAT-8 with European landings in the UK and France, and subsequently in the Pacific with the NPC cable with landings in the continental US and Alaska.

Extensions of the branching unit concept were developed further on the TAT-9 project where there was a total of five different landing points.

2.2 PERFORMANCE AND AVAILABILITY

The ring network concept came about as a result of the need for higher levels of availability, together with the requirement for cable-on-cable restoration. In other words the network design was customer-driven in that the customer requirement for a high level of performance for their circuits meant that ring networks were the obvious answer.

The TPC-5 network is a pre-eminent example in the Pacific region.

2.3 LOW CIRCUIT COSTS AND NEED TO MAXIMISE TRAFFIC FLOWS

Whilst technology has facilitated the provision of systems having ever higher circuit capacities, the benefits of low circuit costs only come about as a result of high fill, or utilisation, factors.

New non-traditional operators entering the submarine systems operating market have, not surprisingly, been keen to use the very latest technologies in order to benefit from the potentially low circuit costs offered by such systems. However, as already stated, these systems must carry a large proportion of their total circuit-carrying capability if they are to offer their investors the returns they are seeking.

In order to maximise the traffic on a particular system, the network designers and planners endeavour to arrange for the cable to land at as many different countries as possible in order to maximise the cable utilisation.

One of the most pre-eminent examples at the present time must be the FLAG cable which is to be installed between Europe and Japan with a record thirteen landing points. The proposed Pacific Transit Cable (PTC) linking Chile and South America with Australasia and the Far East is another example.

It is not easy, or perhaps even appropriate, to generalise about the trends in procurement of the different network types, but Figure 1 conceptualises the situation. In the diagram we see that the traditional operators have adopted the new network concepts as they have become available, but that the non-traditional operators have generally adopted the very latest network concept at the outset, obviously to obtain the maximum competitive advantage right from the first deployment of the system.

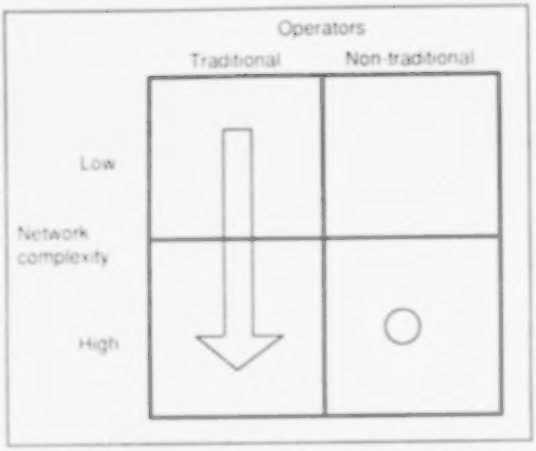

Figure 1: Utilisation of networks by competing operators

3 NETWORK TYPES

To meet the requirements identified in section 2 above, a number of technological different options have been generated. The implications and the benefits provided by each include:

3.1 SIMPLE BRANCHED SYSTEMS

Where the number of key players in a project and the number of those players wanting to be landing point parties exceeds two, but the traffic requirements are such that it would not be economic to provide two separate cables, then a non point-to-point system can provide the solution. In many instances a simple branched arrangement as shown in Figure 2 can offer an acceptable solution. Such configurations are now quite common having been implemented on projects such as TPC-4 and NPC in the Pacific, and TAT-8 in the Atlantic. The Branching Units developed for these applications can conceptually comprise any one of a number of different types including passive, and active/switched types.

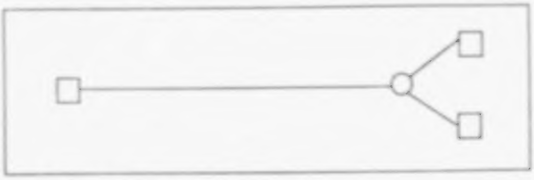

Figure 2: Branched arrangement

3.2 MULTI-BRANCHED SYSTEMS

The growth in telecommunications globally is such that, whereas a decade or so ago the use of submarine cable systems was restricted to a relatively small number of countries, nowadays most countries with sea access would like to be connected to a submarine cable system of some sort. There have been instances where a branched arrangement would provide a solution in principle but, where there are four (or more) landing point parties, a more sophisticated solution has to be found to meet the parties' requirements for adequate traffic connectivity yet at minimal additional cost.

The solution that was found and first deployed on TAT-9 in the Atlantic was to deploy special Branching Units (see Figure 3), which could provide what these days is known as add-drop multipliexor functionality. These particular Branching Units have come to be termed Underwater Branching Multiplexors, or UBMs. UBMs can conceptually provide a totally flexible inter-connectivity capability whereby they can be remotely commanded to provide for various traffic flows between any two landing points - a sort of central office switch under the sea. UBMs have the particular advantage that only traffic destined for a particular landing point need land at that point, and hence a high level of traffic security can be assured. On the other hand UBMs tend to be expensive and significantly more complex than simple passive Branching Units.

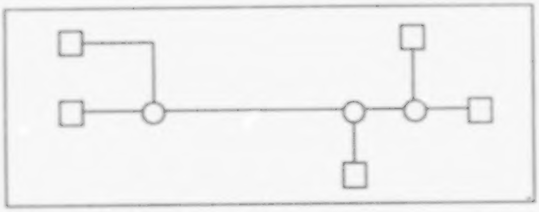

Figure 3: Multi-branched arrangement

3.3 RING NETWORKS

Telecommunications end users are becoming ever more sophisticated and demanding in terms of the performance they expect to be provided by network operators. The major, often global, customers such as the major banks, airlines, computer bureaux, and the like are now demanding that their circuits, and particularly their private data circuits, should have service availability performance levels of 99.98% or better. Such requirements are exceedingly demanding and far from easy for network operators to achieve. For a number of years it was possible for operators to achieve this level of performance by offering satellite restoration paths in the event of a cable failure, be it intrinsic or extrinsic, in the submarine cable system. However, customer expectations have increased such that restoration via satellite is often now considered to be unacceptable, due to the much greater inherent propagation delay. Thus it is that cable on cable restoration is now a major requirement on many routes.

For landline systems this requirement is being taken into account in network design with the introduction of SONET and the Synchronous Digital Hierarchy (SDH), whereby ring networks providing near instantaneous automatic re-routing are a basic feature. With this type of arrangement a failure on any one path results in the traffic being automatically re-routed the other way around the ring, thereby maintaining connectivity, and with the objective of no calls being prematurely terminated.

The application of the ring network concept is now being implemented on major submarine cable projects in both the Pacific and the Atlantic Oceans. In the Pacific, TPC-5 is to be installed commencing 1995 with a ring network interconnecting Japan, Guam, Hawaii, the USA and a direct link back to Japan. In the Atlantic the TAT-12/13 network will inter-connect the USA with the UK, France and back to a separate second landing point in the USA, with a landline inter-connexion between the two USA landing points. The TAT-12 part of the network is to be completed by 1995.

Although the ring network does not require any Branching Units, sophisticated multiplex equipment is needed at each of the terminals in order to detect a failure at any point in the ring and ensure that the traffic is appropriately routed so as to circumvent the fault and thereby maintain the high level of availability needed. The obvious downside with the ring network is that considerably more cable is needed than with a point-to-point or branched system which means that the system cost is generally likely to be double the cost of a point-to-point system. The basic arrangement is shown in Figure 4.

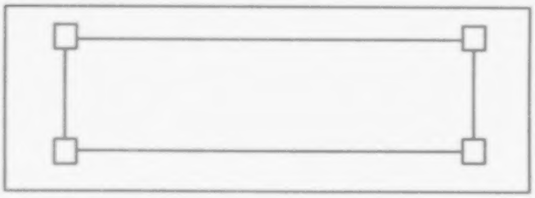

Figure 4: Ring network

3.4 COLLAPSED RING NETWORKS

The advantages of the ring network have been explained in 3.3 above, but it does have the major drawback of being a very high cost solution. However, one of the reasons why the ring network is, in principle, attractive in the submarine environment is that submarine cables can be susceptible to external (or extrinsic) damage from ships anchors and trawler dragnets. Whilst reputable suppliers take every precaution to minimise these effects, by burying the cable for instance, it is nevertheless prudent to be cognisant of the possibility of extrinsic problems. It should be noted that these extrinsic problems invariably occur in the relatively shallow water parts of the system at depths down to around 1000 metres.

Recognising this STC has proposed a solution which provides all the benefits of a ring network solution, but at a much reduced cost compared with a true ring network. The concept is called a collapsed ring network and is shown in Figure 5. It can be seen that in the deep water part of the system where the probability of extrinsic faults is minimal the ring network reverts back to a single cable. With this arrangement the costs are substantially as for a point-to-point system but with additional spurs at the shore ends to improve the system availability. The Branching Units at each end of the system can be inexpensive passive BUs.

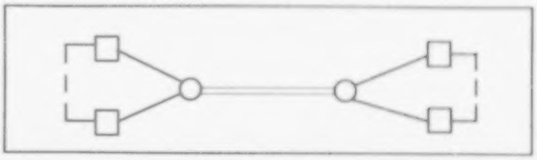

Figure 5: Collapsed ring network

A subtle variant of the collapsed ring is what is known as a multi-point collapsed ring. In this case there are numerous landing points, perhaps ten or more all requiring to be inter-connected. To ensure adequate availability a ring network would be the obvious solution. However, a ring network catering for ten or more landing points is exceedingly expensive and to all intents and purposes makes the network non-viable economically. The answer is to use the multi-point collapsed ring as shown in Figure 6. In this arrangement the long-haul parts of the network comprise a single cable, thereby keeping the costs down, and a spur is provided for each landing point. The fibres within the cable can be looped in and out of each landing point to provide the ring network functionality. Probably the first application of this concept is the APC(N) system planned to inter-connect Japan, Korea, Hong Kong with Indonesia, Thailand, Malaysia, the Philippines, Taiwan and Singapore around 1996.

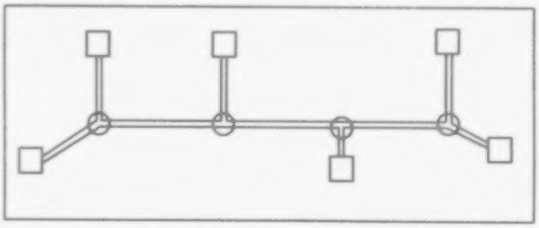

Figure 6: Multi-branch collapsed ring network

3.5 COASTAL FESTOON SYSTEMS

As previously mentioned the demand for telecommunications connectivity is such that, whilst in the past, submarine systems tended to be deployed only on long-haul international systems, they are now finding wide application in regional and national coastal festoon type systems. As a consequence there is a growing demand for submarine systems which interconnect towns and cities along a coastline. In some instances such coastal festoon systems might be just a couple of hundred kilometres long; in others they may be a few thousand kilometres long. There are now many systems either already installed such as the Thailand Domestic system or being planned such as the Hawaiian Inter-island network.

Coastal festoon systems are often competitively priced compared with the alternative media such as landline cable, microwave, and satellite. They have the particular advantages of not being affected by the normal problems associated with landline cables such as backhoes digging up the cable during construction activities; and with respect to microwave and satellite they are not affected by adverse weather conditions such as hurricanes, which can demolish microwave towers, and of course do not suffer any propagation delay as is the case with satellite transmission.

There are two main network arrangements which are available for coastal festoons, and these are shown in Figures 7 and 8. Figure 7 shows the approach which has been widely adopted and is the arrangement deployed on the Thailand Domestic system installed by STC in 1993. It uses the very simple arrangement of just looping in and out down the coastline at each desired terminal landing point. This approach is very attractive since unrepeatered spans of 300 km can now be achieved and 400 km has been demonstrated by STC, on most projects there are usually major conurbations along a coastline within these distances making the coastal festoon very attractive.

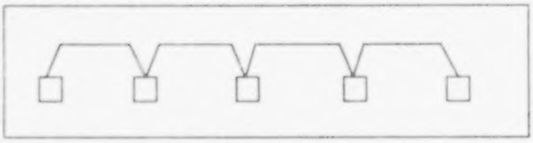

Figure 7: Coastal festoon (loop in/out)

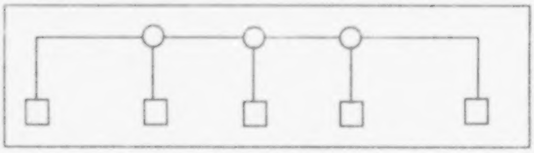

Figure 8: Multi-branched coastal festoon

A more recent alternative approach has been to adopt the arrangement shown in Figure 8 in which there is still the desired connnectivity, but it is achieved with the use of branching units and just a single cable being landed at each terminal location. This has the particular advantage that in the event of a cable fault in any one spur, the traffic routed elsewhere on the system will remain unaffected. The Branching Unit can be one of a number of different options viz:

- a passive BU with fibre routing of the traffic
- an active BU which switches the traffic to divert around a failed spur
- an Underwater Branching Multiplexor (UBM) which electronically extracts the desired traffic data for transmission down the spur

Each of these techniques has its own distinct advantages in respect of cost and reliability and availability.

4 SUMMARY OF OPTIONS

Sections 2 and 3 discussed the main network options as applied to submarine cable systems. It is important to state at this point that it would be imprudent to generalise and recommend particular options in a paper such as this. When planning a submarine cable system it is important to consider all the relevant factors which will include traffic forecasts, geographical routings, economics as well as political considerations. It is not practical therefore to provide a ranking of each of the options. Nevertheless a summary of the benefits of each of the options has been provided (see Table 1) which can help in making the necessary judgements.

Arrangement	Advantage	Disadvantage
Simple branch	Helps politics Minimal extra cost	
Multi-branch	Helps politics	Cost of UBM
Ring network	High availability	High extra cost
Collapsed ring	High availability Minimal extra cost	
Multi-branch collapsed ring	Overcomes high cost of true ring	
In/out festoon	Low cost	
Branched festoon	High availability	Slight extra cost

Table 1: Relative merits of different arrangements

5 THE GLOBAL NETWORK

The growth in submarine cable systems around the world means that by the year 2000 there will be few countries with a sea coast which are not connected to a submarine cable system. Figure 9 shows very graphically how the world might be interconnected by the end of this century. Furthermore, in the remaining years of this decade a higher proportion than ever before of the systems to be installed will be other than simple point-to-point systems, ie they will be networks of one sort or another.

Although the systems shown in Figure 9 may look rather like a birds nest, in fact if the systems are categorised we can start to see some very significant strategic thinking occurring amongst the various operator factions.

For instance we can observe competing traditional and non-traditional networks. In the former category we see projects such as TPC-5 and APC(N) and in the non-traditional arena we see projects such as FLAG and NPC. There is little doubt that there are a good many other projects in both categories in the pipeline.

Exciting projects which are being studied include the Pacific Transit Cable which is expected to run from Chile to New Zealand with intermediate connexions to many of the Pacific islands. Projects such as this will transform the fortunes of the island economies enabling them to begin to attract valuable investment with consequential benefits in terms of standard of living, etc.

The good news is that the ultimate telephone user will at last have a choice which will inevitably provoke the competing operators to both improve on existing service offerings and provoke the introduction of new services.

Furthermore, the flexibility offered by these sophisticated global networks will facilitate the provision of virtual networks which permit tailored connectivity at the will of the customer.

6 FUTURE TECHNOLOGY TRENDS

Speculation as to further developments in the networking arena is not easy. However, one development which is almost certain is the application of wavelength routing based on wavelength division multiplexing (wdm) principles. With such an arrangement a number of different wavelengths would be transmitted down a fibre and particular wavelengths would be routed down the desired spurs to their intended destination, using wavelength filters, etc.

A further feature of advanced networking will be the impact that more complex networks will have on the network management functionality. Already on ring networks we are seeing some very sophisticated software having to be deployed, which allows for control signals being routed over different paths with varying delay times, interconnecting four or more nodes on the ring. The level of sophistication is unlikely to get any simpler given that networks with thirteen or more landing points are currently being planned.

7 CONCLUSIONS

Submarine cable system technology has now become so sophisticated and advanced that almost any interconnexion arrangement between countries can now be achieved at an economic cost and with a very high level of performance. Such network flexibility means that countries who once would not have even dreamt of having access to a submarine cable system are now able to take advantage of this technology. Even at the regional and national levels such connectivity will assist countries to improve their relative economic and social standing relative to their neighbours and the rest of the world.

The benefits to a country of obtaining international access are enormous in both economic and sociological terms. It is the hope that mankind will benefit from this explosion in communications capability leading to long-term peace and prosperity throughout the world.

Todays network solutions are unlikely not to develop further, although exactly how they might evolve further is not easy to predict just for the moment.

Certainly, the concept of Northern and Southern hemisphere digital super-highways facilitating the interconnexion of the world's major conurbations is not at all far-fetched, and could be a practical reality by the end of the decade, providing a major gangplank for global telecommunications in the next century.

We must not forget that these developments are not taking place just because the technology is there, but because the customers' needs can best be met by the provision of such infra-structures. Moreover, the network configuration will inevitably evolve as customers' requirements evolve–after all it is the customer who is King!

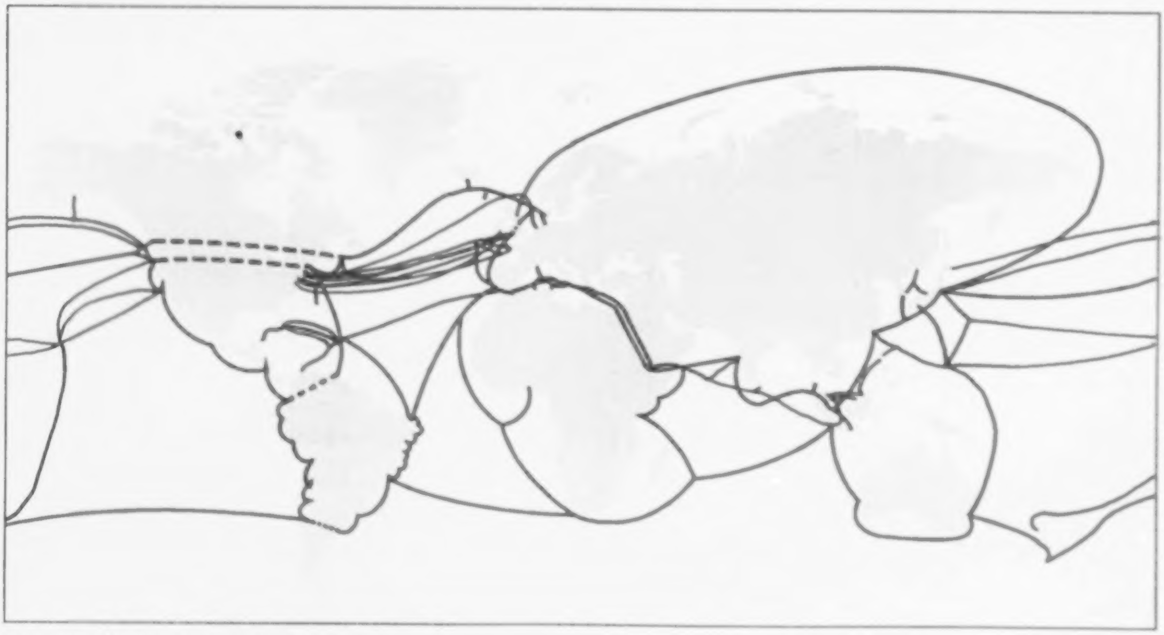

Figure 9: Worldwide intelligent network

Optical Fiber- New Directions and the Future

Neil M. Tagare
Vice President-Marketing & Business Development, FLAG

It is a pleasure to once again be here at PTC '94 -- and to offer my company's view of the future of the submarine cable industry from both a technical and a marketing point of view. And, of course, those two points of view are interdependent.

For those of us in the telecommunications business -and particularly in the submarine cable field -- these are exciting times. There are massive changes under way in virtually every market that we serve. During the next decade, the pace of change will probably accelerate -- and that is going to mean even more challenges -- and more opportunities -- for all of us.

For example, international carriers are realizing that the monopolies which their governments have granted them -- could be swept away by forces in the marketplace. Those who are ready to adapt to that challenge have an unprecedented opportunity to grow beyond the limits of their current forecasts. And those who fail to prepare for this new future could end up on the scrap heap of history.

I'm here today to talk about these changes -- and to suggest at least one way for a carrier to compete effectively in the emerging international marketplace.

The prime mover in the transformation of the telecommunications industry is the end user-- the customer. Never underestimate the power of the customer. Or his knowledge. These days, because of international television -- and data bases anyone can dial into -- that customer has developed a very clear picture of the variety and quality of services that are available -- and their pricing.

As a result, he is becoming much more demanding. He wants better service -- and lower prices. And he is tired of the monopoly attitude of the traditional carriers.

Today's end user -- if it is a major company -- isn't content to sit and wait for the local carrier to change. Telecommunications is such a critical growth factor today, that the company may be willing to move its data communications centers to another country -- where the service is better and the price is right.

In fact, corporations are moving production facilities, too, when that serves their best interests.

Back in the 1970s and 1980s, manufacturers moved facilities to Asia Pacific in search of lower labor costs -- better quality -- and higher profit margins. This "revolution" involved blue collar jobs.

Today, it's the white collar jobs that are going abroad.

For example, American Express processes most of its guest check stubs in Barbados -- where it can maintain a low error rate at equally low costs.

Arthur Andersen, the U.S. accounting firm, developed a major hospital management package for a large client in Chicago -- using programmers who are logging into Chicago from Manila.

Another U.S. accounting firm, Ernst & Young, regularly contracts programmers in the Republic of China to work on special software projects.

Texas Instruments maintains more than a hundred programmers in Bangalore, India, via dedicated satellite links from the sub-continent to its London and Texas facilities.

Clearly, these kinds of jobs can be transferred successfully to emerging nations with underemployed, well-educated populations. All it takes is state-of-the-art telecommunications.

The fact is, the race is on between countries around the world to attract end users -- their data centers -- their factories -- their business.

What companies are doing is downsizing their operations and combining this with a move to a better telecommunications environment. In effect, they are expanding their communications capabilities, while phasing out redundant data centers.

A good example of this is Phillips B.V., which cut its data centers in Europe from 14 to four -- and relies instead on its "managed bandwidth" telecommunications network to support centralized processing.

We mustn't forget that the cost of a computer center is a combination of the price of the technology, the people and the telecommunications. A computer center can be anywhere in the world -- as long as it can communicate with the rest of the world -- and that communications link is reliable and cost-competitive.

For example, American Express' Travel Related Services ships 159 million bytes of data every night -between its data center in the United Kingdom and its Texas data center. That kind of capacity enabled American Express to reduce its work sites from twelve to four -- and it now does all of its Travel Services data processing in Texas.

I guess you could say that there is a quiet revolution going on -- one that can shake the foundations of carriers all around the world. And it is extending to the small user, too.

That isn't just an individual calling home. It is the small business with a global reach -- and that is the new species of business that is evolving as a result of two factors: the worldwide downsizing of big business -- and the growth of international telecommunications. And everyone -everywhere -- is looking for a better deal.

That isn't the only trend that PTT's have to be concerned about. Communications satellites are another source of competition for local telephone carriers. Some day soon, private consortia, launching low earth orbit satellites, will be offering global telecommunications services to customers of local carriers -- directly -- without the assistance of the local network.

Combined with international V-SAT networks, this phenomenon could make international circuit resale a reality.

Of course, a country could make this kind of competition illegal within its boundaries. But technology has a way of re-shaping the law. Look at the success of CNN's penetration in about two hundred countries -- despite the stiff opposition and outright bans by many countries. You just can't build walls around a country any more.

Look at what happened to broadcasting in India. For years, government-controlled television produced mediocre programming -- but advertisers and viewers had no choice. The regulations allowed no alternative.

Then entrepreneurs in Hong Kong launched Star TV via satellite. They started playing special programs just for the Indian market-- popular movies and local talent. Now, viewers had a choice -- and advertisers had to spend their budgets in Hong Kong to influence the Indian audience. There was nothing the Indian government could do. Shootinq down satellites is illeqal!

There is another marketplace force at work on our business: the telephone credit card.

Five years ago, if you wanted to make a phone call from Zurich to Cairo, you needed a direct connection between those two points. Today, Americans traveling abroad can use their credit cards to call from Zurich to Cairo -- through circuits that go back to the United States first. That takes care of foreign exchange problems. And with the speed of transmission these days, no time is lost.

In fact, within Great Britain, Americans are even making calls from London to Brighton -- via the United States. Needless to say, that costs more than using the local telephone lines -- but the power of the credit card is awesome. It's a lot easier to pull a credit card from your pocket -- than trying to figure out the local exchange rate. Too much long division.

Today, this kind of service is reserved for people with U.S.-based credit cards. But what about tomorrow?

Americans aren't the only people who are attracted by the call now/pay later convenience of credit cards -- and the desire to pay in their own local currency. So there is no reason why the carriers in other countries won't offer the same service to their citizens.

So a call from Zurich to Cairo could go through Japan -- or Germany -- or the United Kingdom -- or anywhere else.

Moreover, carriers from these countries could start providing similar credit card services on a worldwide basis -- accepting local currency in every country they serve.

Eventually, the result could be multiple carriers offering service from every country in the world -- competing with local providers for every international call.

It will be easy for a foreign carrier to compete with any PTT in the world: all it has to do is offer a credit card.

There is another force at work in this quiet revolution: the potential power of the small nation. All that a country needs is a concentration of the right technology -- at the right price -- to become a major communications center. Even the smallest country can become a hub for international communications by offering the latest technology at a competitive price. There are hundreds of such potential "mini-hubs" all around the world.

But the competitive key is providing fiberoptic circuits -- and all of the other "bells and whistles" that go with them -- to move data rapidly and accurately. That is what the end user demands. And for good reason.

An organization like the Society for Worldwide Interbank Financial Telecommunications -- SWIFT-- clears 5 million international money transfers a day -- worldwide -between 2300 financial institutions in 70 countries.

And the U.S. Federal Reserve system plans to clear 30 million checks a day by the end of the decade -- not as paper, but as electronic images. And they will undoubtedly need additional capacity for identification data -- such as voice prints and fingerprints. And the U.S. is a trend-setter.

Major end users will increasingly demand other services -- such as multi-media, image processing, video conferencing and distance learning. To be competitive, a country's telecommunications network must be able to accommodate -- and manage -- these high bandwidth technologies.

As I said earlier, even the small user is going to demand the best-- and complain if he doesn't get it from his local carrier. This is also a customer who is ripe for jumping to a neighboring country where the network is more versatile --sometimes even at a premium price. Because the call may be more important than what it costs to complete.

The country that has access to the best technology will have a tremendous competitive edge.

Privatization is also changing the competitive picture.

As telecommunications providers move from government ownership to privatization, the pressure is on them to become profit centers, instead of cost centers. And that includes their submarine cable divisions, the area with which I am most familiar.

It is becoming their responsibility to put the right technology in place -- to manage it and market it competitively -- in a global arena-- and to show a profit. Now, it isn't just the government that will scrutinize them. They will be reviewed by the financial community, their shareowners, boards of directors, and potential investors.

So they have to get the most bang for the buck. In the submarine cable industry, history isn't on their side.

Traditionally, when an international carrier plans an investment in submarine cable, it never installs just what is needed today, or next year. The carrier has to look ahead and forecast demand over the next ten or twenty years. That works out to a lot of up-front expense.

In fact, when carriers come together to collectively consider the installation of a new cable system, the new cable would never be built if current demand were the only standard. So they divide up the total cost of the cable on the basis of their predicted needs ten or twenty -- or even fifty -- years in the future. Which means that they wind up with a lot of spare capacity on their hands -- that they've paid for -- and that isn't earning a penny for them.

Take a look at this chart. In this example, even though the carriers collectively may have a current demand of only 5,000 circuits, they may end up paying for the entire cable capacity of 120,000 circuits. Although this is an exaggerated example, the reality is in the same order of magnitude.

In fact, in order to make this investment more palatable, carriers use the term "notional capacity" -- which is the projected capacity they are buying over the long term -- thirty years, for example. But the notional capacity of a cable is perhaps no more than 50 per cent of the actual total capacity of that cable.

In effect, carriers purchasing notional capacity on a new cable are really buying capacity for up to 50 years in advance. However, today they are making that commitment in a far different climate: traffic patterns change faster -- in more directions -- than ever before. Purchasing fifty years in advance does not allow the required flexibility needed to compete for this business.

And maintenance expenses over the lifetime of the system are almost equal to the total cost of construction. And the international carriers pay those expenses, too.

That leaves a carrier with a fiberoptic network that keeps eating revenues -- but is seriously underutilized.

Today, when the pressure is on the submarine cable division to be a profit center -- instead of a cost center-that situation will become increasingly intolerable.

And what that means is that the newly privatized carriers have become accountable in the short term -rather than the thirty- or fifty-year horizons of governmentowned monopolies-- in consortia, building submarine cable

In today's money markets, you can't raise capital to finance fifty-year dreams. That's too long for new money to wait. You had better be dreaming five- or ten-year dreams -- or they're going to remain dreams.

And therefore, this is going to be the question that will be asked: "If there is an alternative that can offer circuits 50% cheaper than you build them, and make a profit on this pricing, what is wrong with you?"

In my view, that question is going to generate a massive reorganization of the submarine cable industry. In fact, I predict that ten years from now

-- all fiberoptic submarine cables will be privately financed -- or they won't be built.

And, a further question - what features will this privately financed cable offer?

I predict it will incorporate erbium-doped optical amplifiers with pump lasers. It will probably operate at 5 gigabits per second, at least.

It will be SDH-compatible and it will fully conform with all of the applicable recommendations of the ITU's Telecommunications Standardization Sector.

The Synchronous Digital Hierarchy accommodates virtually any signal that can be transmitted -- past, present and future. Carriers will no longer have to back-haul an entire bundle of signals -- demultiplexing stage by stage -in order to access a particular signal.

SDH allows every signal to be visible and accessible. This translates into much less hardware -- and much lower operating costs -- than previous transport architectures.

Because of the extraordinary number of overhead channels built into the SDH signal, carriers will have greatly improved network management capabilities. These data channels allow communications between intelligent nodes on the network, permitting administration, surveillance, provisioning and control of a network from a central location. And none of these management functions impacts the cable's capacity.

SDH means enormous benefits for the end user, as well. Service intervals can be reduced to the time required to convert customer's requests to service orders -- and to transmit these orders to service centers.

And SDH can provide users with greater control over traffic dropped out at nodes. For example, SDH supports a user varying between voice and highband data traffic -- on the same path -- based on time-of-day requirements.

Overall, the greatest end-user benefit of SDH is its intelligence -- its ability to provide the user with information he can use to manage his own communications network-even on a global scale. It is as if the end-user is, in effect, running his own telephone company. He will be in full control of his telecommunications environment -- over the carrier's facility -- and the end-user will pay for his usage of that facility.

Turning away from the technological features of the privately financed cable of the future, let's look at the finances involved. The privately financed cable will make the up-front investment -- and take the risks that go with it. In essence, those risks are taken from the PTTs -- to a market-driven pricing model. And that is to their benefit.

By their resources -- to end-user services for near-term profitability. No more the need for long-term forecasting -- or the investment in future inventory -- thirty or fifty years down the line.

Considering the disastrous affects of market forces and changing technology on forecasting, that will be a relief to the PTTs. Moreover, circuit prices and maintenance prices will be fixed, making life much easier for the carriers planning groups.

In the past, there was so little capacity available that carriers would grab all they could -- and the whole cable would be sold out at the signing of the construction and maintenance agreement.

Network planners were afraid that there might not be another cable built on that route -- and if they didn't have enough circuits for their future needs, they would be hurt. But forecasting proved to be a very tricky business.

Back in 1956, for example, the first transatlantic cable -- TAT-1, a coaxial cable -- had a capacity of 36 circuits. But only 15 were actually sold. The forecasters looked ahead and, in their wisdom, predicted an annual growth in demand of one circuit per year. Some even suggested that TAT-1 would suffice until the end of the century.

In terms of undersea cable forecasting, that set the pattern. Every forecast since then has been just as wrong. Even in 1989, when TAT-9 was being planned, the forecasters predicted that it would have enough capacity to serve until the end of this century. As you know, that isn't exactly what happened.

By 1997, nine transatlantic fiberoptic cables will provide a total capacity of 400,000 digital circuits, or as many as 2 million voice grade circuits. And that doesn't even include satellite capacity.

What it comes down to is this: You cannot forecast the number of people that will cross a bridge by counting the number of people that swim across the river.

The nature of the traffic across the river -- and its volume -- will be completely different when the bridge is built. Just think of the potential new applications that will use that bridge.

With the investment efficiency offered by a privately financed fiber optic cable, the dollars -- and the human resources -- that might have gone into building and maintaining an international communications infrastructure -- can be put to better use -- developing the highly profitable end-user applications. And that means greater, near-term profitability.

One broadband application driving this trend today is medical imaging. Someday soon, someone living on an island in Indonesia will consult with a medical expert in Rome -- via medical imaging -- without traveling one kilometer. This technique extends the reach of scarce medical resources through remote diagnostics.

Another example is distance learning. This will enable our children and our grandchildren to learn from the leading minds of their times -- at Tokyo University or Harvard -right in their own classrooms in Macao, or Argentina or Senegal.

Even in our day-to-day work at the office, we will engage in what I call "electronic immigration"-- logging onto a computer network in India -- and working in London or San Francisco. With the right training, the bookkeeper or accountant of a Canadian firm could be in China.

Already today, several U.S. insurance companies process claims in Ireland, where the cost is 75% lower than in the United States. And it isn't just a question of cost: the accuracy rates at sites such as Ireland and Trinidad are actually much higher than rates experienced domestically.

Here's another example: audio tapes of doctors' case notes are transmitted by several U.S. hospitals to a company in Manila -- where medical secretaries transcribe the data so the doctor has a written record in his computer when he returns to his office the next morning.

And a company like Ford is transmitting 14,000 1-megabyte CAD/CAM files between its European design centers and hundreds of sub-contractors that create components for Ford.

The result is higher productivity -- more competitive prices -- and shorter time to market.

For PTTs, there really is a strong message here. Get in on the ground floor of applications development. The telecommunications business is very much like the PC industry ten years ago: even if there were a PC, there was no software to make it operate. That software wasn't developed by the giant computer companies, but by small entrepreneurial firms.

And look where PCs have gone.

In today's telecommunications market revolution, PTTs should take stock of their greatest asset -- their franchise -that is, their customer base -- and determine what their customers need now -- and will need, in the future.
Then the carrier should seek out the innovators -- the people who will create the telecommunications applications to meet these users' needs.

Develop relationships with them. Instead of massive investments in new product development -- enter into licensing arrangements -- with royalty fees.

These orders for new products will provide the incentives for new applications that will expand the PTT's business -- satisfy the end-users' requirements -- and profit the third-party applications providers, as well.

For the most part, PTTs are not equipped to develop these innovations internally. And experience has demonstrated that this is not an easy skill to graft onto the corporate body.

But by nurturing independent innovators, PTTs gain a significant competitive edge -- through new service offerings -- which they have helped to create without a major investment.

Moreover, the continuing introduction of new products and services -- is a renewal of the PTT's commitment to its franchise -- to its customers, at home and overseas.

Because it meets the standards of tomorrow's telecommunications environment, a cable system like the one I've described will enable you to create a technology platform for your customers. It will be an exciting new venture that will motivate them -- and you -- to break new ground -- to innovate -- to find new applications.

I foresee a world where new entrepreneurial companies, specializing in these new telecom applications, will be as big, if not bigger, than Microsoft.

The only boundaries that limit us are the boundaries of our imaginations.

VSAT -ECONOMICAL SOLUTION FOR INFORMATION NETWORKING-

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1. ABSTRACT

A review of the worthiness of the VSAT in connection with economy, especially in the data networks, is presented in this paper. The economical advantages of the VSAT networks compared with the terrestrial networks for several situations are included. Also outlined in this paper are network and equipment design considerations to establish an economical and efficient VSAT network.

2. INTRODUCTION

It has been about ten years since the VSAT appeared in the telecommunication industry. Recently, the VSAT market is growing all over the world. However, it is not so big compared with the growth of the computer networking market. This is mainly because the market is not enough to aware of the advantage of using VSATs for computer networks.

The interest of system integration of computer networks is directed to application software rather than communication lines. This is reasonable, because it is the most important portion of the system and the interface to the end users. However, sometimes communication cost of the system can be reduced by using VSATs, reducing the overall system cost.

Private computer networks are regarded as closed network rather than open networks. Even if there is a connection to the public network, the number of connection point is limited. The network is characterized by its number of nodes, distance between nodes, traffic volume, the type of traffic (transaction or batch) and topology of actual data flow (star, mesh or tree). The economy of the networks vary with these parameters and in some cases VSATs are worth using. The economical advantages of VSAT in some model cases are presented in the following section.

On the other hand, the VSAT network itself should become more and more economical. In order to reduce the cost, two different factors should be took into account. One is the initial investment and the other is the running cost. The system integrator tends to put higher priority on initial investment rather than the running cost. However, the running cost is more important than initial cost if the network is operated for a longer time. Thus, in the network and equipment design, reduction of the running cost is one of the dominating factors.

The network parameters to be considered are satellite access method, protocol to be used, data rate for the VSAT outbound and inbound channels, modulation scheme, network management system hardware and software, equipment parameters, and how to use the advantage of the satellite communications, in particular broadcasting.

3. ECONOMICAL ADVANTAGES OF VSATS

General economical advantage of using VSATs compared with terrestrial lines is presented. The computer networks are basically configured as point to multipoint or multipoint to multipoint connections. In such situations TDM/TDMA type of VSATs are suitable, because many terminals can share one carrier for satellite communications.

The first parameter to be considered is the number of sites which corresponds to the number of VSATs. The general tendency is that if the number of VSATs increases, the more economical the network becomes compared with terrestrial networks. The reason of this tendency is the HUB equipment cost for the VSAT network. For VSAT networks, having large number of VSATs, the cost of HUB station is negligible.

The second parameter to be considered is the distance between stations. The general trend of this is that the more distance between the nodes, the more economical the VSAT network becomes, as far as the nodes are within the satellite beam coverage area. And the emergence of the crossconnect transponder will enable to economically expand VSAT networks into different beam areas.

The influence of distance on the economy of VSAT networks and terrestrial networks depends on the existence of terrestrial network. If some sites are located far from the other sites and there is no digital terrestrial link existing between them, VSAT is the practical solution for the time being until the terrestrial communication link is installed. This might happen in some island areas and in case the system crosses the boarder. Even if there is a terrestrial communication link, the cost for communication between long distant sites is not so cheap as VSATs, which cost is independent from the distance.

The third parameter to be considered is the traffic volume. The traffic volume is related

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with the application of the system. If the application has large volume of constant traffic, like teleconferencing systems, VSAT may not be suitable. However, applications like banking systems, stock exchange, credit card verification, SCADA, do not require large volumes of data transmission and the sites are rather distributed. In these applications, VSAT networks have an advantage over the terrestrial network because the required bandwidth is not much and flat rate will be applied for the cost of distance in case of satellite communication.

The fourth parameter to be considered is topology of the actual data flow. For example, the host to terminal network's data flow usually have a star topology while distributed processing network have a mesh topology. The existing public switching network is usually configured as a tree network with some kind of hierarchy, which is mainly due to the cost for the cable installation. However, data flow of each end user can not always be fitted for this. On the other hand, the physical topology of the TDM/TDMA type of VSAT network is star topology and the cost for the communication does not depend on the distance between HUB and VSAT.

Even if the actual data flow of the network is mesh topology, only two hops of links are required for all connections. This is feasible only in the satellite communication environment, because the terrestrial distance between stations is not related to the cost, as mentioned before. By using this network, service providers can provide the service to many end users just like any public network.

The fifth parameter is the type of traffic. One of the weak points of satellite communication is the delay over the satellite. This delay will affect to the response time of transaction type of traffic. However, being different from telephone conversation, very few applications require short response times, like less than 1 or 2 seconds. The satellite link transmission itself requires only 0.25 second for one way and 0.5 second for round trip. Thus, if the traffic analysis has been properly performed, there will be no serious problem for response times. And even if the initial traffic analysis has not been done properly, network tuning can be done afterwards by using statistical information, gathered by VSAT network management system.

4. DESIGN CONSIDERATIONS

In this section, the design considerations required to reduce the cost of VSAT networks are considered. There are two major categories in this field. One is the running cost and the other is the initial cost.

4.1 REDUCTION OF RUNNING COST

There are several factors, which determine the running cost of the network. The two main factors are transponder lease charge and the network operation and maintenance cost, if companies or government agencies own their own networks.

4.1.1 TRANSPONDER LEASE CHARGE

The lease charge of transponders is usually determined by the power or bandwidth used by the network. Higher efficiency of satellite access methods will contribute to reduce both transponder power and bandwidth. Therefore, the satellite access method is one of the key issues for the economy of VSATs.

In order to reduce the required power of the transponder, the easiest way is to increase antenna diameter. However, if the antenna diameter is increased, it will increase the initial cost, which includes not only the antenna cost itself, but also installation cost and the cost of required space. If the antenna is placed on the roof, also the strength of the building has to be taken into account for bigger size of antennas.

If the antenna diameter cannot be increased, the next step is to increase the performance of the equipment. The performance of the equipment contributing to the satellite transponder power is the noise temperature and BER performance of the VSAT, because the power of the transponder is mainly dominated by the power of the outbound carriers, which are supposed to be received by much smaller antennas than the HUB station. To raise the BER performance, the adoption of a stronger Forward Error Correction method for the outbound carrier is recommended.

In order to reduce the transponder bandwidth, higher modulation schemes and higher frequency stability of transmitting and receiving station are required. But these will increase the cost of the equipment. Currently, QPSK modulation and several tens of KHz receiving LNBs are compromising points for major manufacturers.

4.1.2 OPERATION AND MAINTENANCE COST

The cost for operation and maintenance is mainly dominated by personnel expenses and facilities.

In order to reduce the number of personnel involved in the operation, a centralized network management system with a graphical user interface is usually utilized for VSAT networks. As the current hardware of VSAT network management systems are mainly work stations, using UNIX OS operating X-windows interface with pointing devices like a mouse or tracking ball. The trends may be further moving towards personal computer as the performance of personal computers is improving. Thus, the familiar graphical user interface for people may be available in the future.

Another way to reduce the operating cost is to share the resources of the network by several users. One of the big cost for small network owners who have dedicated networks is the HUB cost. On the other hand, technically, the RF equipment of the HUB station can be shared by many other users as the RF equipment covers a bigger portion of transponders than required by each user. Thus, the shared HUB service for VSAT networks is very popular these days.

It is also not economical to have an independent network management system for small networks each having their own HUB location. However, if the network management system is shared, it will become feasible for the small network owners. In this configuration, service providers or network operators should own the network management system and are responsible for the whole network operation. The desirable feature of this shared network management system is to provide monitoring and control capabilities to each end user as an option.

What is also essential for the maintenance cost is hardware maintenance action. The reliability of the equipment will determine not only the number of spares, but also the number of maintenance centers and the number of maintenance people.

The flexibility of the system reduces the modification cost when the network configuration is changed. The network configuration change includes the addition and the deletion of stations, change of groups, change of attributes of the stations, etc.

The software maintenance cost is becoming one of the major factors, which determine the maintenance cost for VSAT networks. VSATs contain a lot of software, including: satellite protocols, terrestrial protocols, and network management software.

4.2 REDUCTION OF THE INITIAL COST

The reduction of initial cost is mainly determined by the equipment cost. However, the price of the equipment is a result of trade-offs with other parameters. For example, the functionality, reliability and performance of the equipment are deeply related to the equipment price. Though the determination of the trade-off point is difficult, recent progress in device technology and increased satellite power will contribute to further reduction of the price. Especially, the emergence of the high power and high receive gain satellites will reduce the antenna diameter and output power of VSAT RF equipment.

The protocol to be supported is one of the most important factors to decrease the initial cost. Recently, LAN support capability becomes a big issue for the VSAT networks. Especially, the influence of protocol selection is becoming more important in LAN to LAN interconnections. If the public switched data network is used, LAN protocols like TCP/IP have to be converted to X.25. Though the converters including routers are commercially available, it is not always efficient to use X.25 under TCP/IP, because X.25 implements error detection and retransmission procedures. That will cost the users more time for processing.

As UNIX becomes de facto standard OS for workstations and even for larger computers, TCP/IP will be one of the major protocol for data networks. Additionally, the OS of personal computers also started to support the TCP/IP.

On the other hand VSAT network needs protocol conversion from terrestrial protocol to the satellite access protocol. If VSAT does not support the TCP/IP protocol, double protocol conversion is required. One is for example, TCP/IP to X.25 and the other is X.25 to satellite protocols. Therefore, VSAT networks should support IP router functions or bridge capabilities for LAN interconnection.

By the way, one of the favorable features is that satellite communication can provide a broadcasting capability. Therefore, VSATs should also incorporate this feature. The implementation of this feature depends on the application, but one of the ways is to incorporate the broadcasting capability to the specific protocol. For example X.25 with broadcasting capability may be a desirable solution or TCP/IP with broadcasting may be an another solution. There may be also other ways such as having independent physical ports for broadcasting. The data input to a specific port will be broadcasted or multicasted based on the SG information of the port, in this case.

The actual demand for the network is often a combination of packetized data transmission, stream data transmission and voice communication. The VSAT system design should enable to accommodate the overlay of these networks, otherwise the cost will be increased by having independent network for each of these. One approach is to accommodate voice channels in TDM/TDMA time slots. And another way may be the sharing of the VSAT RF equipment by TDM/TDMA VSATs and VOICE VSATs. If the inband voice approach is taken, low data rate for the voice channel is favorable. And for the toll quality voice communication, the VOICE VSAT overlay is recommended. It really depends on the actual user's demands.

5. SOME CONSIDERATIONS

The above description is to some extent theoretical. The actual situation is more complex. Some considerations should be done for restricting factors.

At first, currently, some countries do not permit to deploy private communication networks completely or partially. Satellite communication is usually included in this case. Therefore, such restrictions shall be taken into consideration.

Secondly, in some countries, satellite transponder bandwidth is not enough to deploy a VSAT network. Or even if there is, a bigger antenna size may be required, because of its location being at the beam edge of satellite beam.

Also, it should be noted that this paper is presented rather from the communication view point. However, for the total economy, more consideration on computer side should be taken into account. Further investigation of economy of computer systems should be a follow-up to this paper.

6. CONCLUSION

The activity of economy is spreading on a world wide scale and a boarderless society will emerge. Many companies deploy offices all over the world and are communicating with each other, all sharing information through data networks.

Also the deregulation in the communication world seems to be developing in many countries. As a result of deregulation, transborder and transcontinental VSAT communication will be realized and will contribute to companies, which have global networks. The further deregulation will remove the boarders between the communication and broadcast service providers. In such time the fusion of the multimedia broadcasting and VSAT technology will be a fact and VSATs will be coming into our homes. For example home shopping, home banking, software down line loading will be done with the combination of DBS receiving and VSAT transmitting functions.

We hope that the next decade will be a prospective era for VSAT technology and that the people in the world can take advantage of VSAT technology, further accelerating the economy of VSAT systems.

Tradeoffs In VSAT Network Design

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1. ABSTRACT

Very small aperture terminals (VSAT) networks are a fast growing segment of satellite applications. Particularly for developing countries, VSATs provide an economic and quick solution for implementing communications throughout the world. VSATs provide both data and voice solutions for a variety of network sizes and topologies. As VSAT networks are more widely implemented, many organizations, previously unfamiliar with satellite communications, are evaluating and selecting VSAT systems to provide for their communications requirements.

This paper presents the architectural choices available to the VSAT network designer and discusses the tradeoffs in performance and cost among the various VSAT architectures. The goal of the paper is to provide system designers with an analytic framework for evaluating the optimal design solution against a given set of requirements.

2. INTRODUCTION

A VSAT can generally be defined as any satellite earth station whose antenna diameter is less than 3 meters. While this definition adequately describes the physical attributes of a VSAT, it does nothing to define the technical and economic choices that are available when designing a VSAT system. In fact, several different network architectures and topologies are possible. In designing and implementing a VSAT network, it is the goal of the designer to optimize both the cost of the network equipment (capital equipment cost) and the cost of the transponder utilization (recurring cost of operations).

Beyond the size of the dish, all VSATs share in common the ability to communicate over a satellite link to another earth station. The destination earth station can be either another VSAT station or a larger earth station. The key differences among VSATs revolve around the methods utilized for accessing the space segment.

3. CLEAR CHANNEL VERSUS MULTIPLEXED DESIGNS

The most basic distinction among VSAT architectures is whether the satellite channel capacity is dedicated to one user or whether multiple users are multiplexed together over the common resource. A clear channel circuit based system will allocate a full duplex circuit from one point of the network to another point of the network. In this environment the satellite network will transmit every data bit received from one end of the network to the farthest end

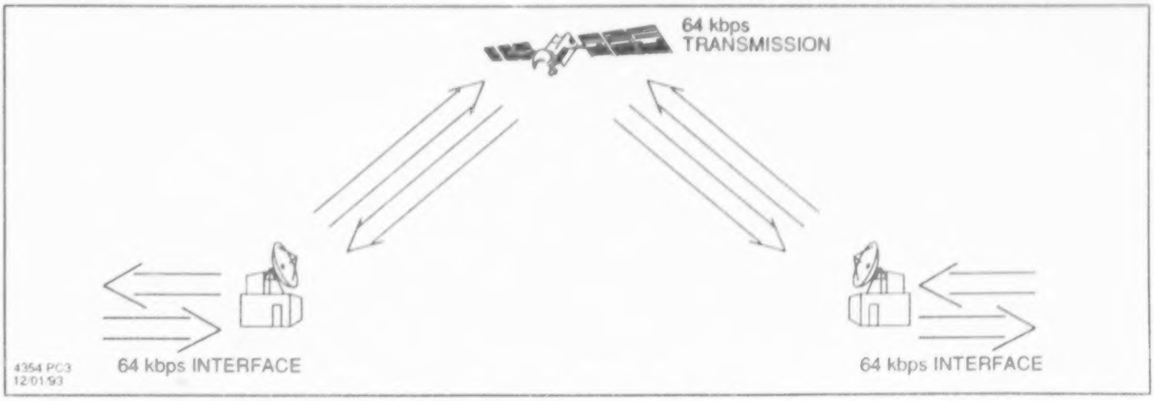

Figure 1. Circuit Access

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of the network in the exact order received. The output of data bits at the far end matches exactly the input of data bits at the origination. Thus, a 32-kbps interface will consume 32 kbps of satellite bandwidth. Figure 1 illustrates how a clear channel circuit based resource is utilized.

A circuit based system is well suited economically for voice channels but can also support data channels. Circuit based architectures are well suited for mesh topologies and can use preassigned single channel per carrier (SCPC), demand assigned multiple access (DAMA) SCPC or time division multiple access (TDMA) channels.

A packet based system will "packetize" the data to be transmitted across the satellite. For data lines such as SDLC and X.25, this type of system will terminate the link layer protocol before data is transmitted across the satellite. This feature allows the VSAT system to recognize protocol frames that are to be transmitted across the satellite and to discard the nonproductive supervisory frames. The result for this type of system is that data transmissions are very efficient. A packet based system is well suited for data channels but also supports voice channels. Typical packet based architectures are of a "star" topology and use time division multiplexed (TDM) outbound channels and multiple TDMA inbound channels.

While both a packet based system and a circuit based system can support voice and data, the economy (in particular the efficiency of the space link channel) is different, depending on the application requirements. The choice of which architecture to use is based on the topology requirements (star, mesh, point-to-point), interface requirements (two-wire or four-wire voice, data or clear channel), traffic volumes (number of sites, erlangs per site for voice, packets per site for data) and performance requirements (single hop versus double hop, call setup time, data response time). The network designer must understand the benefits and limitations of these systems and be able to evaluate the cost of solving an application requirement.

4. SATELLITE TRANSMISSION TECHNIQUES AND VSAT TOPOLOGIES

The simplest satellite transmission technique is the preassigned SCPC technique. This method is a circuit based access scheme and consequently provides a simple circuit from one point to another point. This method is very useful, both economically and functionally, when all that is required is a transmission link from one station to another station.

Figure 2 illustrates how such a link would appear.

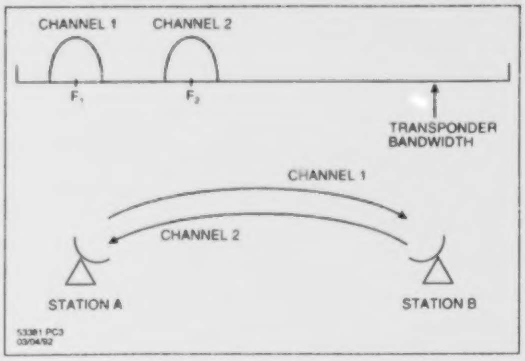

Figure 2. SCPC Access

Each station transmits a carrier at a unique frequency that is not shared with any other stations. Station A transmits at f_1 and Station B transmits at f_2. On the receive side, Station A will receive at f_2 and Station B will receive at f_1. These satellite channels are on fixed frequencies and are not shared with any other stations.

Should multiple devices or multiple channels be required to communicate between these two stations, it is possible to either add more SCPC channels or to simply add multiplexers that combine these devices onto the common channel. This method of adding multiplexers is called multichannel per carrier (MCPC) and is an extension of the SCPC access scheme. Figure 3 shows how this access scheme can support multiple devices and channels. This type of link is very efficient for multiplexing between two stations.

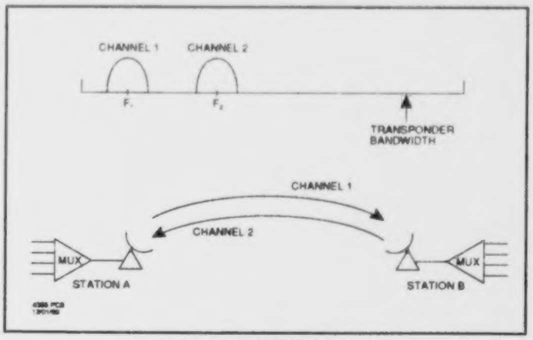

Figure 3. MCPC Access

By using an MCPC configuration to provide multiple channels between two stations, it is possible to use lower cost RF equipment (smaller antenna and smaller amplifier). These multiplexers can be TDM or statistical multiplexers (Stat Muxes). TDM muxes provide fixed amounts of bandwidth to individual channels and are well suited for applications where the bandwidth requirements for each channel do not vary. Stat Muxes are packet based and can provide bandwidth for individual channels based on the instantaneous requirements of each channel.

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Many private users are attempting to provide communication links from a single central location to multiple remote locations. This type of configuration is typically referred to as point to multipoint. Figure 4 shows how such a configuration would be set up. Where the number of remote sites is small, the most common access scheme is SCPC or MCPC.

Another common access technique is the TDMA technique. In this access scheme, all stations transmit and receive on the same frequencies. The access to these frequencies is based on time. The satellite bandwidth is "divided" on the basis of time to provide for access to the common frequency by multiple stations. A map of when each station is to transmit, called the "network burst time plan," is used to ensure that each station transmits its "burst" of data at the correct time. The network timing and the network burst time plan together ensure that no more then one station will transmit over the frequency at one time. On the down link, each station will "see" or receive from the satellite a series of bursts from all the stations in the network. On the receive side, the stations will use the burst time plan to determine which data bursts are directed for them and should be decoded and passed to the connected devices.
Figure 4 shows this topology.

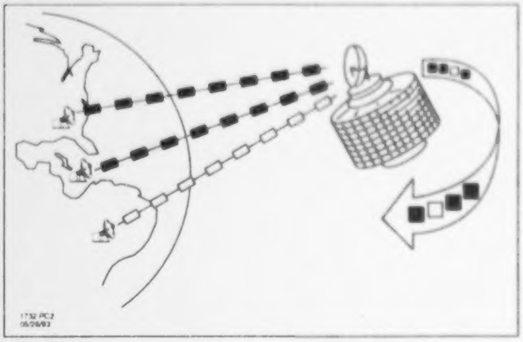

Figure 4. TDMA Access

While LBR TDMA systems are typically circuit oriented, it is significant to note that many provide DAMA for these circuits. Using the DAMA scheme, the TDMA burst time plan (or network connectivity) is adjusted to provide optimal utilization of the bandwidth.

When considering TDMA access for VSATs it is typically necessary to consider only low bit rate (LBR) TDMA. LBR TDMA occurs when the transmission rate over the satellite is less than 8 kbps. Higher bit rates generally mean that a larger antenna (4 meters or more) is required as each station requires higher gain for the larger carrier.

LBR TDMA networks can provide either "mesh" connectivity, where any station talks to any other station, or point-to-point connectivity. Figure 5 illustrates the different topologies that are possible with the LBR TDMA scheme.

Where the number of remote sites in a "star" topology (point-to-multipoint configuration) is large (more than 20 remotes), satellite transponder economics usually dictates that a packet based TDM/TDMA access scheme be used. In this scheme the central station, or hub, will transmit a TDM outbound carrier to all of the remote stations. The data transmitted over the TDM outbound channel is packetized and addressed to individual remote stations. The remote stations transmit back to the hub station using TDMA access of common inbound channels. The use of TDMA provides an efficient scheme for coordinating the transmission of data from multiple remote sites to the single hub site. Such a system is illustrated in Figure 5 below.

By using a packet based TDM/TDMA, users are able to achieve an economy of higher bandwidth utilization. Additionally, these types of systems can perform "protocol processing" or termination of the data link. For polled protocols such as SDLC, this termination can provide good response time as the polls do not travel over the satellite.

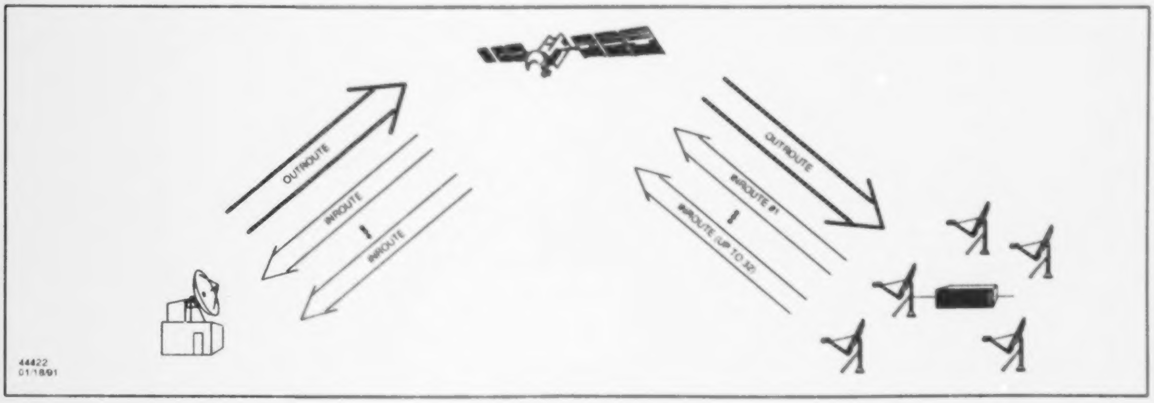

Figure 5. TDM/TDMA Access

5. APPLICATION REQUIREMENTS

In determining which access technique and network topology to use, it is very important for the network designer to fully define the applications that are to be supported and determine the performance that is required.

The network designer must first evaluate the topology of the network. The questions that need to be answered are:

Size of Network - How many stations must the network support?

Network Topology - Will the network be mesh, star or point-to-point?

Network Expansion - How much expansion is required in the future?

Available Transponder - How much transponder capacity is available for the application, either due to economic limits or commercial availability?

Next, the designer must characterize and quantify the traffic that is to be supported. The first issue is to define what amount of the traffic is voice and what amount is data. For voice traffic it is important to understand the following:

Voice topology - Mesh or star?

Distribution - Is voice supported at each site?

Interfaces - Do remote sites interface to two-wire handsets (subscriber lines), private branch exchange (PBX) extensions (ring down lines), PBX tie lines, or public switched telephone network (PSTN) trunk lines?

Erlang Load - For peak busy period, how many calls are generated and what is the average duration of each call?

Signaling - Is connection into the PSTN using the PSTN signaling required?

For data traffic it is useful to characterize the following:

Data Topology - Mesh or star?

Interactive or Batch - Must the data connection be maintained in an "online" mode or can the application be supported in a "dial-up" mode?

Interface Rates - Async up to 19.2 kbps, sync up to 64 kbps, sync beyond 64 kbps.

Line Utilization - What is the load of each line; less than 20%, 20%-50%, or more?

Network Protocol - SNA/SDLC, X.25, TCP/IP, asynchronous, and so forth.

Finally, the desired performance of the network must be determined. For voice the following are the key performance issues:

Call Block Rate - What percentage of calls must be completed successfully?

Call Setup Time - What is the average time to complete the call?

Closed User Group Support - Are some users prohibited from calling other users?

Dial Digit Manipulation - Do dialed digits need to be deleted or modified?

For data the key performance issues are:

File Transfer Throughput Time - How quickly must the file transfer take place?

Interactive Response Time - How quickly should each transaction be accommodated?

Once these basic design parameters are defined, the network designer can apply the tradeoff of performance against the cost of implementing different design alternatives.

6. ECONOMIC EVALUATION OF VSAT SYSTEMS

Once the network designer has quantified the requirements of the network, it is possible to choose a network design that satisfies the requirements. In many cases there are several network designs that will satisfy the technical requirements. It then becomes important to evaluate the relative economic costs of the designs in order to determine the optimal solution; i.e., the best price for performance.

In constructing the economic model, there are two main considerations. First, what is the nonrecurring or capital equipment cost for the network? Second, and perhaps more significant, what is the recurring cost to operate the network? The major component here is the amount of transponder consumed in supporting the requirements. Evaluating both of these costs is relatively straightforward and provides the network designer with a clear evaluation of the networks under consideration.

In calculating the capital equipment cost, it is important to ensure that all of the items required to operate the network are fully accounted for. This should include the following:

RFT equipment
Baseband and IF equipment
Interface equipment
Network management
Installation materials
Spares

Calculating the recurring cost of the space segment is a two-step process. The first step is to "size" the network design based on the traffic requirements. In the simplest case where an SCPC network supports a 64-kbps circuit, the sizing simply tells us that we need two 64-kbps channels. For a DAMA SCPC voice network, we need to apply the number of erlangs per subscriber line to determine the number of satellite "trunks" that are required.

Once the number and rate of satellite channels has been calculated, we can use the satellite link calculations to determine the exact amount of satellite space segment required to support the applications.

A useful exercise is to consider two different network requirements and calculate the amount of satellite resource required to support these requirements using circuit based and packet based access schemes. The following examples are extreme in their requirements, but serve to illustrate the respective economies of the access schemes.

Consider the following design example for a data oriented network. The requirements for the network can be summarized as follows:

Performance requirement:

- 100 remote stations
- 64-kbps X.25 connection
- Online interactive, 100-byte transaction once per second
- Star topology

Actual throughput per site:

- 100 bytes*8 (bits/byte)/1 (seconds per transaction) = 800 bps per site
- OR 80 kbps per network

Using a circuit based SCPC approach for these requirements we will need the following resources:

- 200 (100 full duplex) 64-kbps channels
- 2.4-meter remotes and 4.5-meter hub
- Each 64 kbps consumes:
  - 0.6% of transponder power
  - 0.25% of transponder bandwidth
- Total network requirements:
  - 120% of transponder power
  - 50% of transponder bandwidth

Conclusion: More than 1 transponder

Using a packet based TDM/TDMA approach we would be able to fulfill the network requirements with the following resources:

- Multiplexed traffic using protocol spooling software
- 1.8-meter remotes and 4.5-meter hub station
- 128-kbps TDM outbound channel consumes:
  - 2.2% of transponder power and 1.1% of bandwidth
- 128-kbps TDMA inbound channel consumes:
  - 0.26% of transponder power and 1.1% of bandwidth
- Total network requirement is for 1 outroute and 3 inroutes:
  - 2.98% of transponder power and 4.4% of bandwidth

Conclusion: Less than 5% of transponder

Clearly, in this example, a packet based TDM/TDMA system provides very good efficiency of this data oriented network.

A similar exercise can be applied for a voice application.

Performance requirement:

- 100 remote stations
- Two voice subscriber lines per site
- 0.3 erlangs per subscriber
- 0.1% blocking rate
- Mesh topology

Number of trunks required:

- 75 full duplex circuits

Applying these requirements to a DAMA SCPC system that employs voice activation (VOX) of the carriers requires the following resources:

- 150 (75 full duplex) 16-kbps channels
- 2.4-meter remotes
- Each 16 kbps consumes:
  - 0.1% of transponder power
  - 0.08% of transponder bandwidth
- Total network requirements:
  - 6% of transponder power (4 db VOX savings)
  - 12% of transponder bandwidth

Conclusion: Less than 12% of transponder

On the other hand, using a star, TDM/TDMA system to satisfy these requirements requires additional resources:

- 1.8-meter remotes and 4.5-meter hub station
- Assume ALL voice is remote to remote
- Assume voice uses 5-kbps low rate encoding
- Total network capacity required:
  - 75 (# trunks)*2(double hop) = 150 trunks

- Requires 2 outroutes and 11 inroutes

- 512-kbps TDM outbound channel consumes:
  - 3.0% of transponder power and 4.4% of bandwidth

- 128-kbps TDMA inbound channel consumes:
  - 0.26% of transponder power and 1.1% of bandwidth

- Total network requirement is for 2 outroutes and 11 inroutes:

  - 20.0% of transponder power and 20.9% of bandwidth

Conclusion: More than 20% of transponder

From these examples we can clearly see the necessity to choose an appropriate access scheme based on the application requirements.

7. CONCLUSION

The determination of which VSAT network solution is most appropriate for a given set of requirements can be determined by carefully itemizing the network requirements and then applying these requirements to the different access schemes that are possible. This method provides a clear and objective process to evaluate network designs.

Digital SCPC DAMA:

The Optimal Technology for Satellite-based Voice Networks

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1. ABSTRACT

Satellites have long been carrying voice traffic across oceans and within the boundaries of individual countries. Previously, satellite voice transmission was somewhat limited to high traffic applications such as international gateways and heavy-traffic-per-site networks because individual channel routing technology was too expensive and largely unproven. Today, however, the technology is both proven and affordable. Digital SCPC DAMA (Demand Assigned Multiple Access) allows cost-effective handling of rural and private network traffic without compromising voice quality. This paper will review the key requirements for a private voice or rural telephony network; analyze traditional options; and detail the benefits of digital SCPC DAMA.

2. Introduction

As an alternative to traditional terrestrial communication networks, satellite networks offer a cost-effective option for geographically dispersed locations. While terrestrial networks include traditional metallic connections, fiber-optic connections or microwave relays, satellite networks include a satellite, usually parked in a geosynchronous orbit, and two or more earth stations. Because satellite networks are not affected by rugged or sparse terrain, they often provide a more effective communications solution than terrestrial networks. In countries such as Indonesia, which has more than 13,500 islands, and the Philippines, with more than 7,000, terrestrial options are prohibitively expensive, especially to those islands with minimal traffic. In other countries with vast regions to cover, such as China, terrestrial links to every phone location is virtually impossible. Satellite-based networks, however, can be simply and quickly installed, easily maintained, and can provide complete network control from a central location. In addition, satellite networks allow for encrypted and secure communications when desired.

The use of satellites for voice transmission is no longer limited to international gateway and heavy-traffic route operators. Today, satellite technology is being demanded by thin-to-medium route users. Because of advances in software technology, the cost of providing voice routing on a single channel basis with a single satellite hop connection is considerably less than ever before. Five years ago, a DAMA (Demand Assigned Multiple Access) remote site would cost four times as much as it does today. Furthermore, today's advanced technology allows for toll quality and simple one hop connections using a satellite link while digital compression further reduces the cost without degrading service quality.

3. Users

Currently, there are two primary user groups of satellite-based voice networks that are emerging: private network operators and rural telephony operators. Private network operators consist of national and multi-national corporations and government agencies. Typically, these operators want to establish a network that is independent of the PTT, yet capable of interconnection to the PSTN and other private networks. In addition, many private network operators desire a closed, secure network.

Rural telephony operators consist of PTT's, second carriers and alternative access providers. These users require low cost access to rural areas, fast implementation and PSTN connectivity.

4. Network Requirements

The following are the key requirements those planning new networks should consider:

- Cost-effectiveness: In rural areas, for example, purchasing power is limited. As a result, there is a need for inexpensive communications.
- Reliability/maintainability from master station: Because thin route traffic covers wide geographic areas, it is often difficult and expensive to send repair technicians to remote sites.

  Therefore, the ability to maintain the network from a central station is key.
- Flexibility: A network must be flexible enough to allow implementation in phases. Many users begin with simple voice requirements but later need to expand to data or video. Networks should provide an a-la-carte menu that allows for voice, interactive data, clear channel data, and video.
- Quality: A successful network must be capable of offering a toll quality connection and make satellite links transparent to the user.
- Growth potential: A network must be expandable and able to allow easy upgrades to software and features. A network that cannot meet this requirement will result in a new investment with each technology change.

5. Traditional Satellite Options

5.1 Analog SCPC (Single Channel Per Carrier)

In an analog SCPC network (see Figure 1), dedicated circuits are set up to provide point-to-point connections for voice traffic. The majority of these applications provide trunking between switches. A trunk is seized from one end and acknowledged from the other. The dialed number is then passed and the connection is established. An important feature of SCPC is its voice activation (VOX) operation. Once the call is established, the carriers are keyed to voice presence. If one party is not speaking, their carrier is dropped, making that power available for other carriers. For large networks, this feature can save up to 4dB of satellite power. In a power limited satellite network, VOXing of the SCPC carriers permit transponder operation with up to 2.5 times the carriers supported by non-VOXed SCPC networks. This results in lower transponder cost per carrier.

Some examples of an analog SCPC network include the state of Alaska's back-bone network by Scientific-Atlanta.

Before the advancement of digital capabilities in the mid-1980's, analog technology was key in SCPC networks. However, since the evolution of digital transmission, several disadvantages of analog SCPC have become apparent. First, the available interfaces to public networks are usually limited and require additional signaling converters to work properly. Secondly, providing routing and DAMA control is very expensive. This is due primarily to the difficulty in implementing control channels in an analog system and the high cost of computers with the required amount of memory and speed. Finally, fax and data capabilities are limited to analog in-band data and fax. As a result, the available speeds are quite low.

Because the circuit implementation is done using analog circuitry, all inherent limitations result, including aging, drift and periodic trim adjustments. Manufacturing is also more expensive as a result of the alignment adjustments required during manufacturing.

5.2 Digital TDMA (Time Division Multiple Access)

In a digital TDMA network (see Figure 2), a remote site may have anywhere between one and hundreds of circuits all contending for the same pre-specified satellite bandwidth via a time division multiple access scheme. If a remote is connected to several channels, those channels may share a switch that allows economical use of space resources (assuming that the individual channels are not in constant use 24-hours per day).

The key advantage of digital TDMA is a cost effectiveness for heavy traffic routes. In addition, it allows easy expansion due to the low cost associated with adding channels. TDMA systems come with a range of interfaces including analog and digital connections. Because it is a digital system, E1 and T1 interfaces are common.

The disadvantage of digital TDMA is that all sites must "burst" at the network capacity data rate. Unless all sites are operating at maximum capacity, this constitutes ineffective usage of satellite capacity. Digital TDMA usually requires a more expensive ground segment. Because each site is bursting at network capacity, they must then have the RF power and the larger antenna size to support the higher data rate. As a rule of thumb, digital TDMA is not economical for low traffic volume remotes.

Although a TDMA network can be easily expanded as demand grows, there is usually a limit to the number of sites that a given burst rate may accommodate. When that maximum number is reached, a higher rate burst is necessary. Some newer systems expand by adding additional carriers in a TDMA/FDM format, but here, there are limits to expansion as well.

5.3 Digital MCPC (Multiple Channel Per Carrier)

In a digital MCPC network (see Figure 3), two sites can connect with each other on a pre-assigned satellite capacity, or on a "clear channel." The topology is point-to-point and the destination of the entire traffic stream of each remote is set at installation time. The traffic, voice and/or data, is multiplexed if necessary, modulated, and sent over the satellite to another remote. No hub or master control station is necessary. Data rates of 512, 128, or 64 kbps have been popular with MCPC users, however, with today's modems capable of variable rates in 1b/s increments, the data rate can be set at anywhere from 9.6 kbps to 2mbps or higher.

Digital MCPC's key advantage is its low cost for a small network. It is easy to install and to operate. It is easily expandable with its ability to increase modem speed or multiplexer capabilities. A MCPC system is considered a closed network and does not have a need for data framing or unique signaling protocols. And, because it is a digital technology, it offers all the benefits of digital voice compression, including lower space segment cost and smaller earth stations. In addition, due to its simplicity and point-to-point nature, digital MCPC does not require a network management system (NMS).

The disadvantages of MCPC are a result of its simplicity. Connections between remote sites can be established through the hub in star networks, or direct point-to-point connections with additional carriers. A connection through the hub results in a double satellite hop with an additional delay caused by the second hop. Direct connections require additional point-to-point circuits through the satellite. For a full mesh network, the number of satellite circuits required is proportional to N where N is the number of sites. Since traffic is rarely uniform, the additional circuits are usually not used efficiently.

5.4 VSAT Star DAMA (Demand Assigned Multiple Access)

In a VSAT Star DAMA network (see Figure 4), all voice traffic from remotely located earth stations is routed to the master earth station, or hub. This hub allocates satellite resources as needed. When a remote site uses a shared link to request service, the hub responds, using a shared outlink that serves as a signaling channel. The remote site's call uses two frequency segments since remote calls are transmitted on F1 and received on F2.

Because of the bursty nature of interactive data transmission, the use of a VSAT Star DAMA network is ideal. In addition, this type of network also utilizes smaller, less costly earth stations since remotes always talk to the larger hub antenna.

The disadvantages of a VSAT Star DAMA network is its high initial investment cost. This is due to the expensive master hub station. In general, VSAT Star DAMA networks are not designed for voice, but can provide an adequate "order-wire" quality connection. Remote-to-remote traffic must go through a double hop. In addition, the grade of service is impacted if interactive data and telephony have conflicting throughput requirements since both share the same burst return channels.

5.5 Digital SCPC DAMA

In a digital SCPC DAMA network (see Figure 5), space segment is allocated only when needed. Voice traffic travels on a single channel per carrier and channels are assigned on a call-by-call basis. A specific channel at remote 1 can request a direct connection with remote 2 through the network management system. The request, and the reply, are handled via the NMS outlink and return link channels, operating in a slotted aloha and TDM format respectively. The NMS then assigns two frequencies on the transponder, one from each remote. As a result, the call is connected directly between the two remotes with only a single satellite hop. When the call is complete, the channels are released back into the available pool so that other users can have access to them. The call set-up and the call itself are both digital. Using this scenario, full mesh connectivity is possible, thus ensuring high voice quality.

The advantages of digital SCPC DAMA are many. Because it is space segment efficient, space segment costs are reduced. A voice network with 40% peak busy hour activity per carrier, for example, could reduce the usage of a transponder by as much as 67% when compared to a MCPC or Star TDMA option. In addition, the cost of the ground segment is low, therefore ensuring that the overall cost of the system is also low. The expansion of the network is a relatively simple and affordable task since the incremental cost of each additional channel is low.

Digital SCPC DAMA offers all the benefits associated with a digital network including drift-free operation without aging, as seen in analog circuits. Digital signal processing chips enable implementation of signal processing in software instead of hardware and offer the ability to significantly upgrade the processing capability without a hardware change.

Digital SCPC DAMA offers mesh connectivity from any remote to any other remote. Single hop connections eliminate delays and reduce space segment costs. These features make the digital SCPC DAMA the ideal technology for voice applications while still being able to handle interactive data, high speed data transmissions and video transmission/reception.

Because the network is software-based, remotes are downloadable from the master station. Unattended operation and simple maintenance are allowed with the network management system and the system provides call detail records as well as remote status and control. Upgrades and new features are easily implemented and various signaling interfaces are also available.

The key disadvantage of digital SCPC DAMA is its start-up costs which include a master station with a NMS. However, the use of state-of-the-art PC-based computers reduces this cost significantly over older mini-computer designs. Unlike VSAT Star DAMA, any of the digital SCPC DAMA remotes can become a master site when configured with a NMS. However, when the number of channels per remote becomes very high, digital SCPC DAMA may be less economical on a per channel basis than full TDMA.

6. Digital DAMA Features

A typical digital DAMA system offers VOX operation which reduces the necessary transponder power when conversation is down by as much as 3 or 4 dBs. High quality voice is assured by using voice encoding at 16 kbps (or ADPCM at 32 kbps).

Digital DAMA supports in-band data and in-band fax and offers Fax Relay as an option. Interactive data (X.25, SDLC, ASYNC, etc.) can also be supported with add-on data processing units. Additionally, clear channel data at between 9.6 kbps and 2.048 mbps is supported.

The modem and voice codec are packaged on the same channel unit allowing for a low profile channel unit. Multiple telephone interfaces are built-in and multiple signaling protocols are supported.

7. Conclusion

The price of digital SCPC DAMA technology has dropped dramatically, making it the technology of choice for satellite-based voice networks. The technology allows high quality voice and data connections in areas where terrestrial options are not viable or in cases where an operator may desire a private network. Digital SCPC DAMA allows expandability, upgradability and flexibility. Lastly, it provides easy maintainability, monitoring and control from the master station.

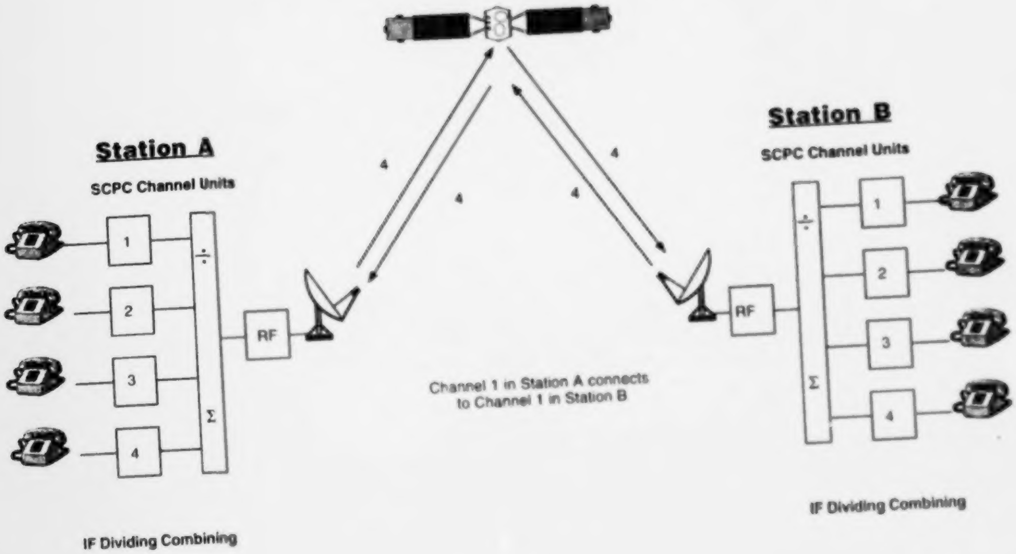

Station A
SCPC Channel Units
1
2
3
4
÷
Σ
RF
IF Dividing Combining
4
4
4
4
Station B
SCPC Channel Units
1
2
3
4
÷
Σ
RF
IF Dividing Combining
Channel 1 in Station A connects to Channel 1 in Station B
NSG-1329A

Figure 1 Analog SCPC

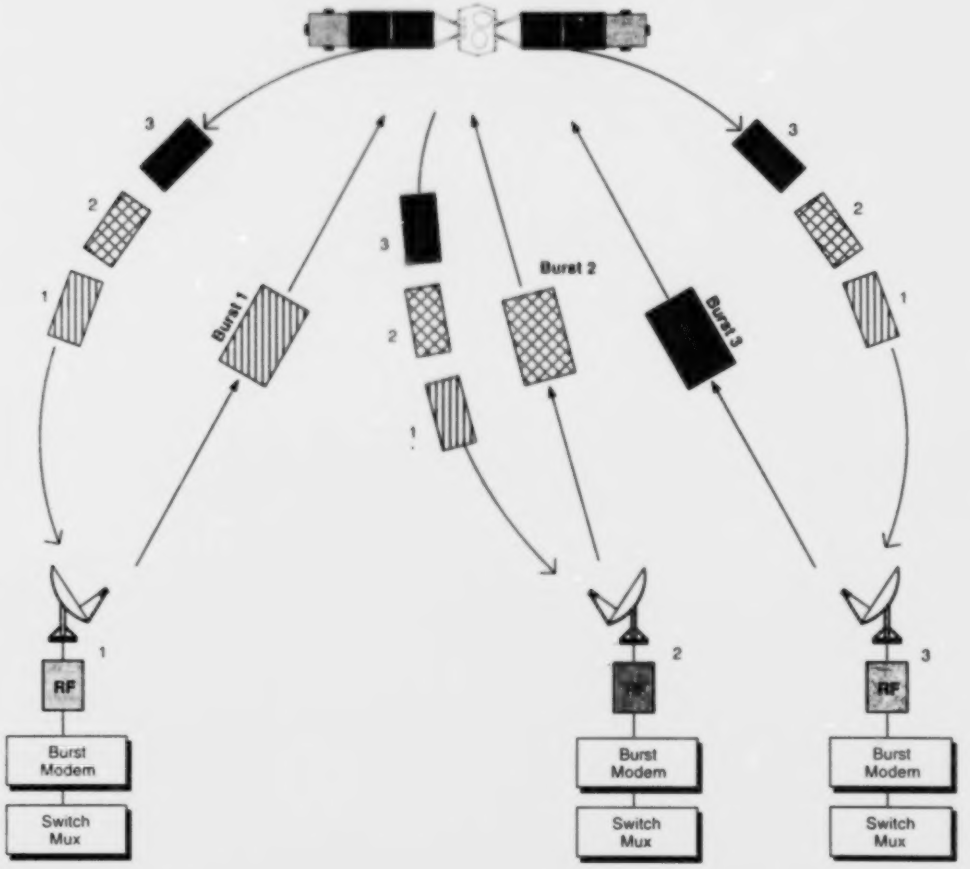

3
2
1
Burst 1
3
2
1
Burst 2
Burst 3
3
2
1
1
RF
Burst Modem
Switch Mux
2
Burst Modem
Switch Mux
3
RF
Burst Modem
Switch Mux

Figure 2. Digital TDMA

NSG 1325A

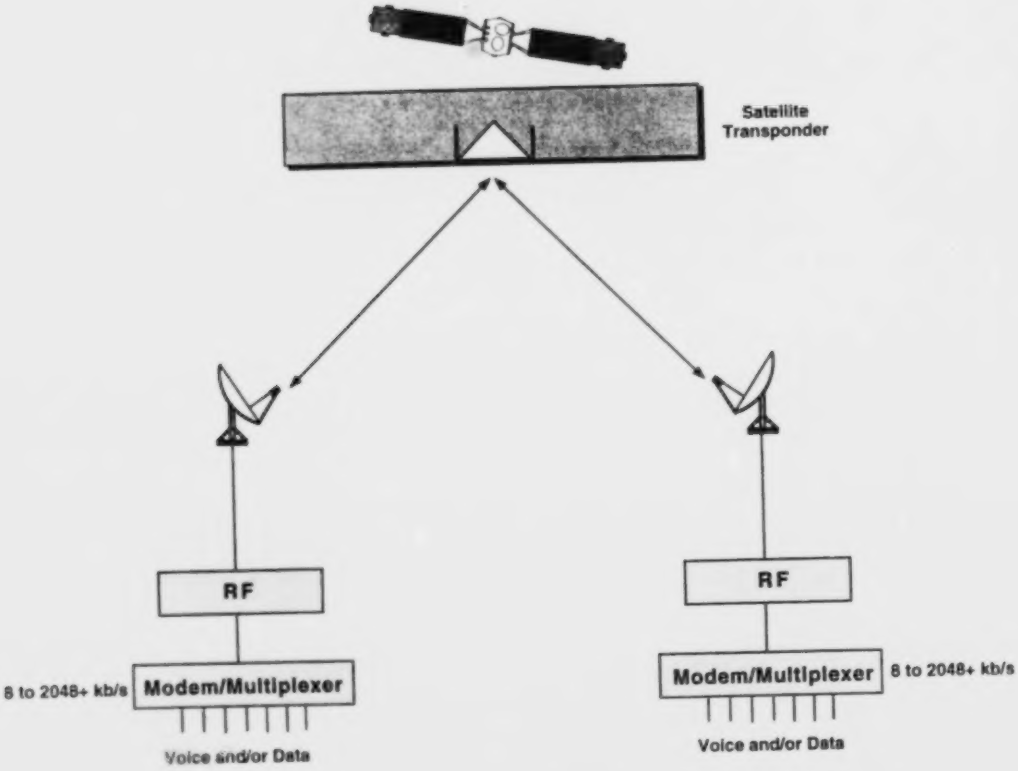

Satellite Transponder
RF
RF
8 to 2048+ kb/s
Modem/Multiplexer
Modem/Multiplexer
8 to 2048+ kb/s
Voice and/or Data
Voice and/or Data

Figure 3. Digital MCPC

NSG-1326A

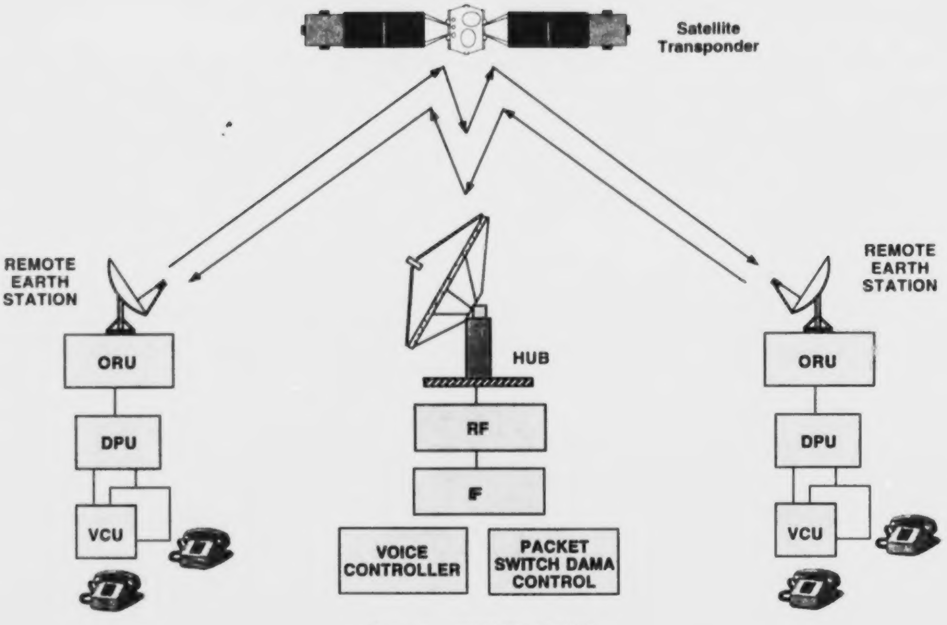

Satellite Transponder
REMOTE EARTH STATION
ORU
DPU
VCU
HUB
RF
IF
VOICE CONTROLLER
PACKET SWITCH DAMA CONTROL
REMOTE EARTH STATION
ORU
DPU
VCU

Figure 4. VSAT Star DAMA

NSG-1327A

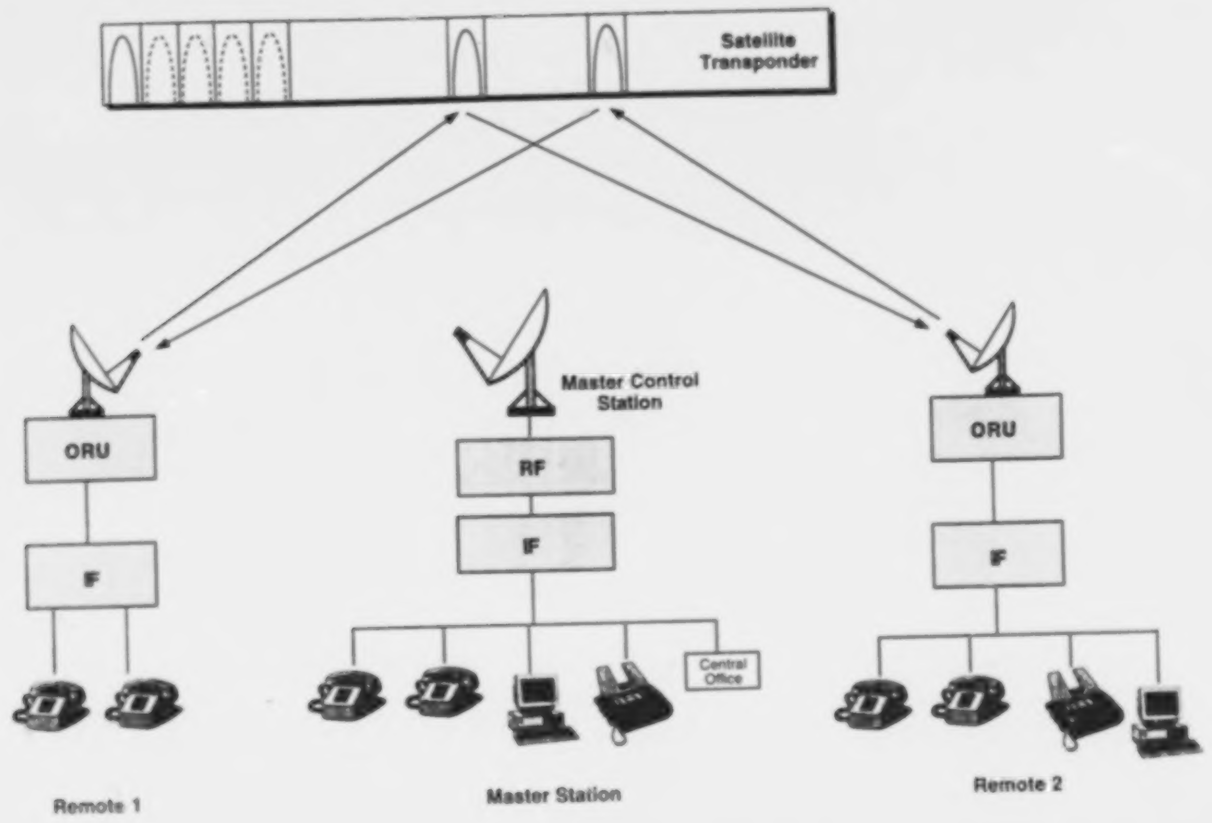
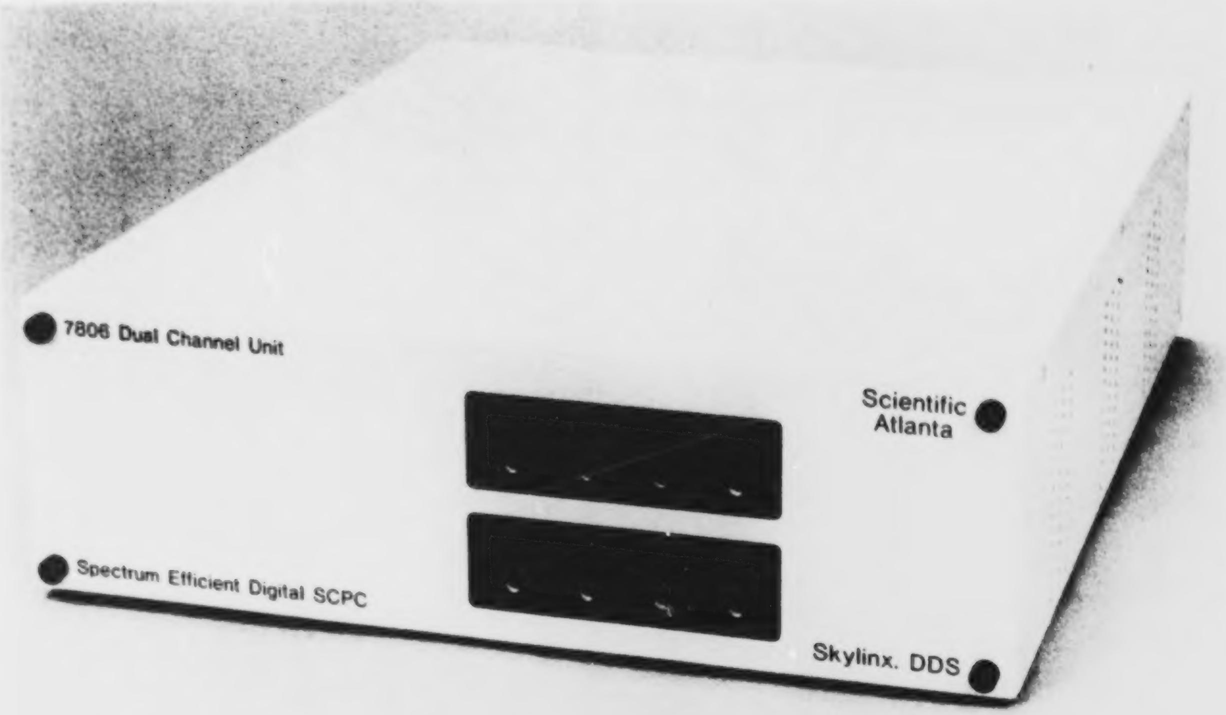

Satellite
Transponder
Master Control
Station
ORU
IF
RF
IF
ORU
IF
Central
Office
Remote 1
Master Station
Remote 2

Figure 5. Digital SCPC DAMA

NSG-1328A


7806 Dual Channel Unit
Scientific Atlanta
Spectrum Efficient Digital SCPC
Skylinx. DDS

Scientific-Atlanta's Micro-DAMA indoor unit includes a modem and channel unit.

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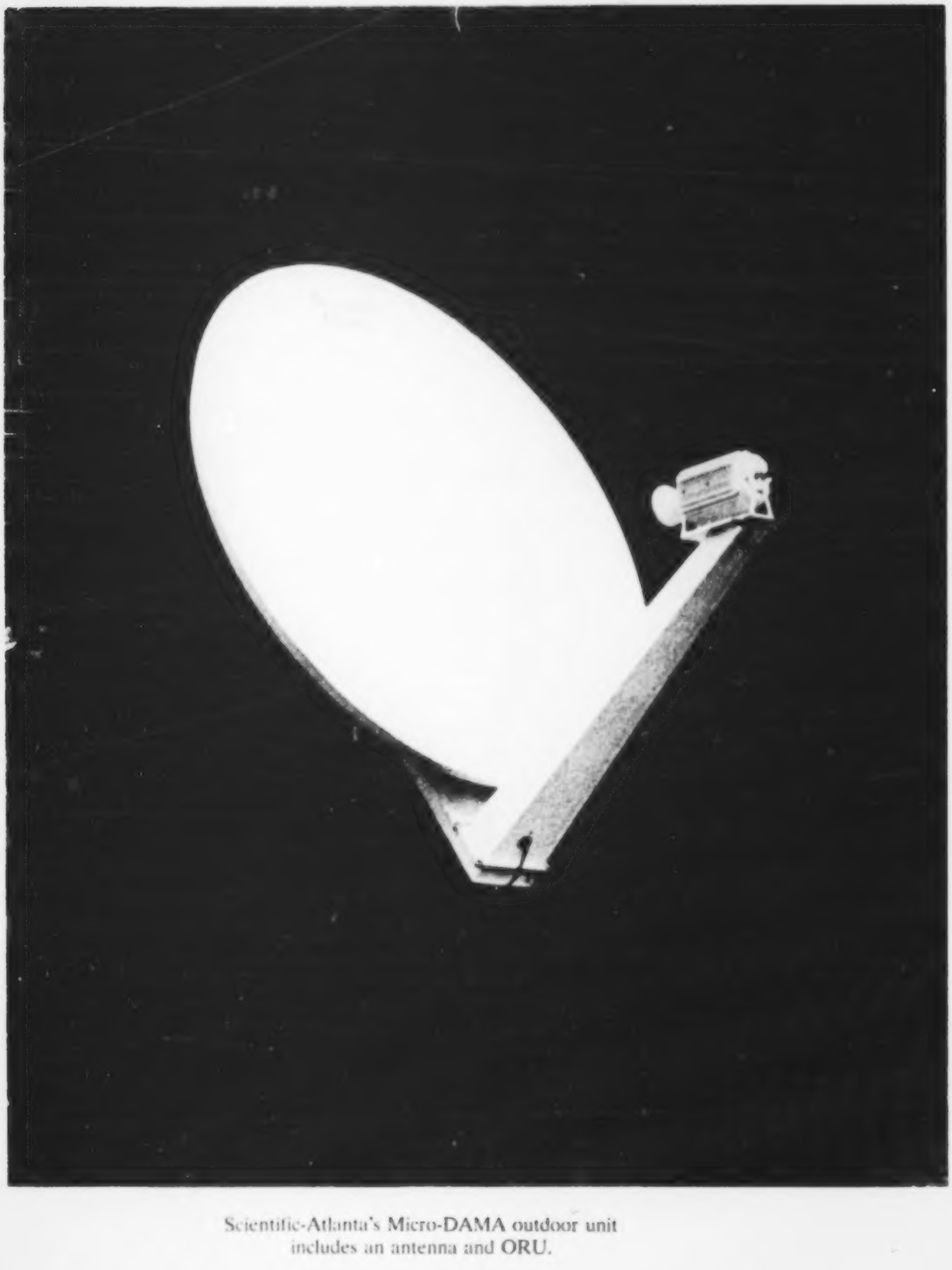

Scientific-Atlanta's Micro-DAMA outdoor unit includes an antenna and ORU.

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A CDMA APPLICATIONS ON VSAT RURAL COMMUNICATIONS SYSTEMS FOR DEVELOPING COUNTRIES

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1. ABSTRACT

Mexico as on other developing countries, had employed on its rural satellite communication systems, FDMA multiple access technique; resulting on an inefficient spectral use. In this paper a CDMA VSAT system for rural application is proposed. The proposed system will enable an earth station to offer voice and low speed data transmission services, that will be excellent for rural communities.

2. INTRODUCTION

Communicating a high number of small rural communities scattered in wide areas of developing countries, has been an incompletely solved challenge for most governments. Mexico is not the exception, with 21 million inhabitants distributed on 153,800 towns with less than 2,500 inhabitants [1].

Mexico used to communicate rural towns, all the ranges of available technologies, resorting to satellite communications, to a small extent in the 80's, but increasing its use in the 90's with the implementation of some state networks.

Presently there are three state-wide rural telephony networks operating in Mexico; Sonora's network has 15 remote terminals with a preassign FDMA-SCPC scheme, Oaxaca's network has 10 remote terminals, following TDM/TDMA access method, when Baja California's network has 9 terminals operating on a AA/TDMA.
The results and experiences acquired are important, nevertheless there are two important aspects to consider.

1) The equipment used is designed for urban use and consequently
2) Their costs are high for rural purposes

The appearance of VSAT satellite systems specifically designed for rural environment is very recent, offered by some European companies and one in North America. Considering that none of these systems provides a universal answer to the problem, in this article is presented a new VSAT system for rural purposes.

3. SATELLITE SYSTEMS FOR RURAL TELEPHONY

In developing countries, to have a network that offers basic communication services like voice, fax and/or low speed data, to remote areas with a difficult access, and sparse population, has a vital importance since these communities can raise their productivity and efficiency to enhance particularly their quality of life and their integrating to country's productivity.

To meet this challenge successfully, a sophisticated equipment is not necessary. Rural communities don't have enough technical support to maintain and manage this equipment; however, if they have a simple but reliable system, a higher successful rate in getting these communities integrated is more feasible.

European countries, like Italy and Belgium, have met this challenge, mainly because the communication needs on Eastern European countries, as well as the potential market that represents developing countries such as Mexico and all Latin America, and has developed equipment specifically designed for rural telephony using SCPC-DAMA and SS-CDMA technologies [2].

Clearly these technologies satisfy the communication needs on rural towns, differing on some important aspects, like telephone traffic, number of nodes, etc., being the access method the main difference that have large repercussions on satellite bandwidth. The preference of CDMA is due to high traffic support with large number of nodes, to justify the requirement of large bandwidth. this work will show that it is not necessary a "large" bandwidth to satisfy the minimum requirement for voice fax and/or low speed data

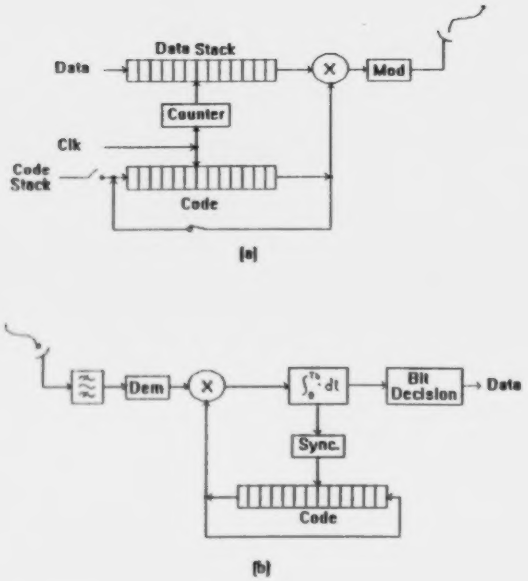

Fig 2 a) transmitter DS-CDMA, b) receiver scheme

Considering the use of digital voice compression, we can calculate bandwidth for the two most likely choices formerly made. For the first one, we have 9.6 Kbps stream from the vocoder, adding 4.8 Kbps of control, header and FEC to total to 14.4 Kbps, using 16 chip code length per bit and considering BPSK modulation, results on 460 KHz bandwidth. Applying the same procedure with 18 chip code length will yield 518 KHz.

Both results are relatively low in bandwidth consumption, but considering that the 60 KHz difference in bandwidth makes a growth allowance from less than two to five times the worst scenario presented, the second choice seems preferable.

Under the same order of ideas, 18 bits code length won't add much complexity, thus cost, from 16 bits option, neither processing time, so that this reasoning leads us to pick up 18 bits code length as the best option for the Mexican scenario presented.

6. CONCLUSIONS

On CDMA the drawback is its bandwidth use, resulting principally from the code length, commercial systems for rural telephony purpose use approximately 27 MHz on Ku band, with 1023 chips code length. Long code implies long tracking and locking time, if the code length reduced, the transmission speed will augment (as it happened on wireless LAN), or the bandwidth will diminish. On the other hand, short length codes redound on simple low cost earth station equipment, and minimum bandwidth use.

On this paper we have analyzed the feasibility of design of as simple CDMA VSAT network for rural application, mainly from the code length point of view and its implications. The main characteristics of the system comprise remote earth station using DS-CDMA, with base-receiver protocol and 18 chips code length spread over 518 KHz bandwidth, which give room for a growth of up to five times the worst case proposed of 480 stations in mesh configuration network.

These results open the path to further analysis of other aspect on satellite network system design, like, link budget, system administration, etc. This applies not only in Mexico but also in Latin America, favoring theirs integration with the rest of the country, and theirs connection to the principal merchandise, services distribution centers.

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4. EARTH STATION

4.1 GENERATION AND CHOICE OF CODE

In CDMA, the bandwidth, the data transmission speed and the number of nodes, is function to the length codes, if you have a reduced bandwidth as it's the case of satellite systems, code selection regarding type, length and use becomes necessary. Studies and analysis on code selection and application on VSAT networks are in references [3] and [4].

On CDMA and specifically for VSAT networks' applications, a suitable node transmitting power control is very important. The objective is to guarantee a unique identity to each station on the network with low cross correlation to avoid the interference and a uniform power transmission to minimize the signal's suppression effects. However, it is not necessary a very low cross correlation level, if the receiver equipment has a good cross correlation decision device.

An A station, with a larger number of 1's on its code, than a B station, will transmit with more mean power than a B station. These complicate the reception process on B. When the code length is long, it does not matter if the station has a perfect balance on theirs 1's and 0's, however for shorter lengths' sequences it's extremely important.

Power levels on ordinary VSAT networks are 1 or 2 watts with an 1.8 m antenna diameter [3]; these calculations made for long (1023) sequence Gold family code, and a big bandwidth (30 MHz).

It could be demonstrate, that with a very simple link calculus, the busy bandwidth diminishes, if it transmits with a smallness gain process, maintaining the earth station EIRP.

A simple short sequence code generator can be obtain with shift register, where its output feeds its input on each clock pulse (see figure 1). However, the useful vector numbers for its k code length, are fewer than the 2^k-1 total vectors on the family.

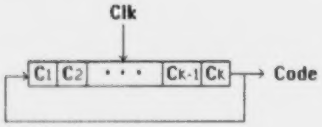

Fig. 1 CDMA simple short sequence code generator

To obtain the useful vectors for different shift register lengths and get the spread spectrum, a software program gave the results shown on Table I. This table includes an approximate calculus regarding the number of channels, users, and using BPSK modulation for 9.6 kbps vocoder transmission speed on 36 MHz satellite transponder. This calculus includes header bits necessary for addressing, synchronization, and for 2/3 FEC bandwidth effects; if it does consider, we would have approximately 14.4 kbps as data rate.

Table I.

Code Length	8	10	12	14	16	18	20
No. of Signals	10	26	80	246	810	2350	≈ 7000
Required BW for 14.4 Kbps and BPSK Modulation (KHz)	230.4	288	345.6	403.2	460.8	512.4	576
No. of Channels in BW=36 Mhz	156	125	104	89	78	69	62
No. of users' in BW=36 MHz	1560	3250	8320	21894	63180	162150	≈434000
Simultaneous access per channel with 30% utilization	3	7	24	73	243	705	2100

4.2 OPERATION

The transmission information using SS/DS/CDMA and a short sequence generator is been done with a system shown on figure 2a, where data is pack under Base-receiver protocol [5], feed a stack (data stack) with an R_b bps bit rate. All the possible stations' addresses (given by the useful code vector numbers) are on a code stack; the code generator will be feed with the unique receiver code, each time the information packet is ready to transmit. The clock rate to be the same as the generator chips rate R_c, that works directly over a counter to control R_c/R_b gain (spreading factor). These data feed the data modular BPSK and later to earth station RF equipment.

Under this scheme, the result is a simple equipment (modem), which its receivers conform the most complex block. Nevertheless the receiver scheme is design for more sophisticated schemes. Using one of this direct sequence receiver schemes as shown in figure 2b, which consider the base-receiver protocol. This scheme has shorter capture time than the same scheme using longer sequence code.

5. MEXICAN RURAL NETWORK SCENARIO.

Setting aside the in homogeneous criteria followed by the states to decide locations to communicate by satellite.

The relationship of their satellite rural networks with the topology and distribution of the existing rural network. We have some elements to extrapolate an approximate scenario for a national rural satellite network. Considering the three experiences formerly explained, we can formulate a worst case scenario for an initial network of 15 rural sites per state, which considering the 32 states of Mexico, adds up to 480 earth stations.

According to the relationship between code lengths and number of stations, 16 bits would be able to accommodate the initial figure of 480 stations, and still allow a growth of approximately 70% more. The second choice of 18 bits codes length would permit a growth of five times the initial figure.

"Wireless networks as a replacement for wireline facilities"

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President - BellSouth Asia/Pacific
Atlanta, Ga., USA

1. Abstract

Wireless communications systems are being used to upgrade the telecommunications infrastructure in developing countries. In many cases, when a cellular network is installed it quickly becomes a surrogate for the fixed telephone network, especially in countries where wireline facilities are inadequate, or are saddled with outdated equipment. Cellular is ideal for this kind of substitution because the cost of installation compares very favorably with wireline installation. Wireless systems can also reach remote, rural areas where it may not be economically feasible to install landline facilities.

Ten years ago, the Independent Commission for Worldwide Telecommunications Development reported that fully three quarters of the world's telephones were concentrated in only nine countries. The Commission noted that it was of the utmost importance to developing countries that they expand their telecommunications facilities and address this imbalance. As the Commission pointed out, telecommunications is "an essential component in the development process which can raise productivity and efficiency in other sectors and enhance the quality of life in the developing world."

Most people in the telecommunications industry would agree with the point that a nation's success in achieving its economic, social and political goals depends heavily upon its telecommunications infrastructure. And indeed, many governments in the Asia-Pacific region are committed to upgrading and expanding this infrastructure.

For example, the government for the People's Republic of China has identified telecommunications as a key to economic development and has set a target penetration rate of 6 to 7 percent by the year 2000, which will require the installation of at least 70 million new access lines over the next seven years.

Thailand has ambitious plans for network modernization, and the government awarded a contract worth $1.6 billion (American) for the installation of one million telephone lines to the country's provincial areas. India is in the midst of a development plan that aims to double the number of telephone lines and increase the route kilometers of the country's transmission network by more than 30 percent.

The government in the Philippines, where the national telephone density is only 1.6 percent and facilities in the rural areas are almost non-existent, has embarked on several programs that aim to improve the country's telecommunications problems. The Indonesia government, also recognizing shortcomings in this area, has initiated several plans to address the situation, including the installation of 100,000 lines in Jakarta. Indonesia also passed a new law in 1989 that allows the private sector to participate in its telecommunications development program.

Malaysia's governing authority plans to establish a fully developed telecommunications infrastructure by the year 2005, as part of its move to bring Malaysia to developed country status by the year 2020. A more immediate goal is to increase the telephone penetration rate to 15 percent by 1995.

Those countries that are serious in their efforts to expand and upgrade their communications infrastructure -- and attract outside investment, technology, and expertise -- will be the countries whose economies stand to benefit the most. All over the world, more and more governments are recognizing this.

In a country where the telecommunications infrastructure falls short of meeting growing demand, the quickest way to extend network facilities is through the installation of a wireless network. This would be a wireless network that serves as a replacement for, or an augmentation to, the existing wireline network.

In developed countries, we have seen the telecommunications market evolve from the fixed network to the analog generation of wireless communications, to what we would call the third generation wireless technologies. These are communications technologies based upon the addition of intelligence to the network. But network operators generally will not invest in third-generation technologies until the second generation wireless network capacity is exhausted, or unless the market demands it.

For rapidly developing countries that have the vision and the determination to go ahead with it, higher capacity wireless networks that are built on intelligent network platforms may provide them with the means to move quickly towards the third generation.

This allows them to achieve cost curves that are lower than the traditional fixed network approach, while gaining services that are more advanced than the second generation wireless networks.

Another form of wireless technology that might be used at some point is "wireless cable." In some early trials in the U.S., companies have utilized spectrum around the 28 gigahertz range for cellular-like distribution of cable television signals. Motorola has also developed a wireless cable system that uses radio frequencies in the 18 gigahertz range.

The possible application for us would be to use that wireless cable technology for the broadcasting of audio telephony -- it would thus provide a wireless connection from the main trunk of a telephone network to a user's location. In other words, the "last mile" of the local loop would be wireless. There are some exciting possibilities here, and the Federal Communications Commission in the U.S. is talking about allocating part of the spectrum for this technology. It could be a very important development in telecommunications.

Is it more cost effective to build a cellular network for the local loop service instead of a wired network? Some research suggests that it can. Datapro, an American firm that specializes in computer and telecommunications research, issued a report two years ago that estimated the costs of installing a wireless system to be very close to the costs of a fixed landline system in an urban environment. It would typically cost about $1,000 per customer to build a wireline network. The cost estimate for a cellular network was also about $1,000 per customer, with the only difference being in the price of a handset -- $50 for a wireline telephone as opposed to $400 or more for a cellular phone.

That same Datapro report contended that in rural areas, where it can cost as much as $20,000 per customer for a landline loop, cellular was already a more cost-effective way to deliver access to the local network. The report concluded that "Mobile communications costs should decline and capacity should increase dramatically with digital cellular and PCN's. These networks will be cost competitive with the telephone network in urban areas and less expensive that the telephone network in rural areas."

Since that report was released, the cost trends in cellular's favor have continued. Granted, the authors of the report were examinining wireless communications in the context of the United States, but I am certain that their conclusions would apply equally well to the Asia-Pacific region. If you compare plain old telephone service against wireless voice and data transmission -- at least up to the transmission rate of 9.6 kilobits per second -- it may indeed be possible and feasible for a wireless system to be a substitute for, or provide competition in, the local loop.

In certain rural applications, wireless may be cheaper: a good example here would be Telefonica of Spain's effort to provide cellular coverage in low-population areas at a subsidized price just to make sure people can use the telephone. Germany's wireless access program (which is called DAL, or Drahlose Anschluss-Leitung) is another example. After the reunification of Germany in 1990, Deutsche Bundespost Telekom, the government monopoly provider of telephone service, was faced with enormous demand in the east German states for access to the fixed telephone network.

This demand for network access was so intense that it could not be met through conventional wireline facilities, so Telekom utilized radio systems to serve more than 45,000 customers in Eastern Germany.

Europe aside, wireless communications systems are also being used to upgrade the telecoms infrastructure in developing countries. In many cases, when a cellular network is installed it quickly becomes a surrogate for the fixed telephone network, especially in those countries where wireline facilities are inadequate, or are saddled with outdated equipment and don't work very well. People forced to wait for many months or even years to get a phone line -- if they're lucky enough to get one installed -- figure out quickly that a cellular phone can provide access to the fixed network. Evidence of this can be seen in usage patterns where BellSouth has been involved in the design and implementation of cellular systems in Latin American countries.

In some of these countries, we have found that people spend an average of 300 to 400 minutes per month airtime on their cellular phone, twice the average rate for the U.S. They are obviously using their cellular phone for the fixed network access they could not get previously.

Wireless communications systems can also reach remote, rural areas where it may not be economically feasible to install landline facilities. Malaysia and Thailand are pioneers, on a limited scale, of using cellular systems to provide rural telecommunications. The Philippines is the first country to try and use cellular to provide rural telecommunications on a national scale.

BellSouth and Cable & Wireless are partners in the company Optus Communications in Australia, where a satellite-based "Mobilesat" system is being implemented to bring wireless communications coverage to the immense, sparsely-settled Outback region of that island nation. In cases like these, wireless is not just a substitute for a wireline system -- it's the only practical system.

It's clear that for developing countries, cellular often provides basic communications infrastructure. It can also extend the reach of telecommunications to people and places that may take decades to reach with traditional fixed networks. Most importantly, it can upgrade the basic telecommunications infrastructure which, in turn, helps bring about increased economic development and job creation.

In its landmark report 10 years ago, the Independent Commission for Worldwide Telecommunications Development referred to telecommunications as "the missing link." This could be interpreted as the communications link between nations and peoples. It can also be interpreted as the link between telecommunications development and a country's overall economic development.

However you interpret it, wireless-based networks will be the keys to installing that missing link. With the many advances in technology, further standardization, and rapid cost reductions in equipment, wireless networks are rapidly approaching the point where they will become the primary local access network in developing nations.

Thanks to wireless technology, it may be possible by the year 2000 to report that we have found the missing link.

FIXED WIRELESS LOCAL-LOOP SYSTEM: A NEW RECIPE FOR SUCCESS?

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1. Abstract

With the emergence of the wireless local loop (WLL) system, cellular technology has now begun to be deployed in developing countries. There is a temptation to conclude that the WWL system is the new panacea for the various problems besetting the developing countries, but is this really the case?

2. Introduction

Telecommunications provision in the Developing World varies considerably between and within countries. Generally however, the average level of provision in developing countries is lower than that of the industrialized world. One of the symptoms of inadequate provision is the overuse of existing local and trunk plants, leading to poor call-success rates, repeated retries and thus greater congestion. Long waiting times for new telephones are typical and, in rural areas, very low numbers of telephones per head of population, are the norm.

Up until recently, cellular telephones have been marketed as a premium service mainly in industrialized countries.With the emergence of the wireless local loop (WLL) system, however, cellular technology has now begun to be deployed in developing countries, where telecommunications operators are confronted with a poor-quality service.

In December 1992, a wireless local-loop system provided by Motorola attracted attention from the trade press when it provided the "missing link" to the Indonesian island of Flores, which had been devastated by an earthquake and tidal wave. This system reportedly took three weeks to deploy from the placement of the order to the actual implementation. Moreover, the implementation cost for this system was relatively low compared to that for its wired counterpart.

There is a temptation to conclude that the wireless local loop system is the new panacea for the various problems besetting the developing countries, but is this really the case? Is a fixed wireless local-loop system able to offer developing countries a cheaper alternative to capital-intensive fixed-wire networks? Is deploying this system really in the long-term interest of the developing countries? Will there be sufficient regulatory safeguards to prevent the sparsely-populated rural areas from being excluded from the network development? This paper will examine these questions from a technological, economic, logistic and regulatory point of view.

The following major manufacturers are committed to a wireless local loop system: Motorola, Ericsson, Hughes Network Systems, Alcatel SEL, Qualcom, Northern Telecom and AT&T. The following is a list of countries implementing or considering the implementation of a wireless local-loop system, plus the suppliers, investors, and technical details of each system.

Telecommunications networks are operated under different circumstances in different countries. In considering the appropriateness of the wireless local-loop system as opposed to the wired system, some obvious factors come to mind --such as geographical variation, population density by region, user requirements, conditions of existing back-bone networks, budget constraint, etc. The situation in each particular country has to be discussed individually but there are some common denominators which can be taken into consideration. These will be discussed as follows.

3. OPERATIONAL/TECHNICAL ISSUES

3.1 What sort of quality is the existing back-bone network? Can it cope with the increased traffic?

3.2 What technology best suits individual situations?

3.3 What are the physical characteristics of the service areas?

- Urban areas? Rural areas? Both?

- Is the proposed service area relatively flat, hilly or mountainous?

3.4 Can a new telecommunications network service be designed, launched and maintained by personnel within the country in question or would someone from outside of the country have to be called in?

Wireless Local-Loop Deployment

Country	Companies Involved	Mo/Yr	Technical Options
Developing World			
	U.S. West	11/93	CDMA (basic telephony)
	Electr. Corp.of Tamilnaru		
India	Qualcomm(S)		
	Sri Lanka Telecom	1993	RF-based system
	Motorola(S)		
Sri Lanka			
	Indonesian government	1992	
	Motorola(S)		
Indonesia			
	Hughes Net. Systems(S)	1992	ETDMA (basic telephony),
			$15 mil. contract
Tartarstan (CIS)			
	"	4/93	ETDMA (basic telephony)
Chengdu (PRC)	Panamerican Cellular	3/93	TDMA, (basic telephony
			& premium mobile)
Honduras			
	Tricom	1992/93	
Dominican Republic	Motorola	12/92	NAMPS
	Ericsson	?1993	RAS 1000
Russia (pilot)			
	Motorola	1993	NAMPS
Czech Republic	Champion Technology	1994-95	
	HNS		
Hong Kong(proposal)			
	Qualcomm	end 1993	CDMA
Russia			
Developed World	Nokia	1992	
	Ericsson		NMT-based and RAS1000
Germany (eastern)			
	Ionica	1994	proprietary
	Northern Telecom (S)		
Finland			
	Ionica	1994-95	proprietary
	Millicom	1994-95	"
United Kingdom	Mercury	?	
	Compagnie Generale		
	des Eaux (CGE)	1994-5	DECT
France			
Note: (S) represents system or equipment suppliers			

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4. REGULATORY ISSUES

4.1 What kind of regulatory framework should be established for WLL? (e.g. What kind of conditions should be imposed on operators?)

4.2 How should radio frequencies b allocated?

4.3 What kind of arrangements should be made for interconnection between the backbone network and WWL networks?

5. FINANCIAL ISSUES

5.1 What are the cost trends in wireless hand sets and network infrastrucfure?

5.2 How could a project involving the launching of a new WWL network service be financed?

We will now examine the above questions (3-5) more in detail.

3. OPERATIONAL/TECHNICAL ISSUES

3.1 Conditions of Existing Backbone Network

The amount of fixed-network coverage and the quality of service will determine the requirements for any proposed radio-based technology. For example, in an area where there is a poor or inadequate fixed system, a radio-based system may be introduced with a view to providing a complete alternative telecommunications system. This is likely to prove an expensive option and improvement of existing PSTN trunk and exchange equipment coupled with widespread use of radio local loops offers a better path towards an improved overall service.

These issues also raise the question of how effective a network based on radio technologies can be in situations where a high proportion of the traffic passes to an existing fixed network?

Where an existing fixed network is poor, but still provides connections to the majority of national subscribers, then no matter how good the radio-based network, it will suffer from the problems brought about by the poor condition of the fixed network. It will also be important for the existing fixed network operator to earn the income from this traffic.

If a separate radio-based network is introduced to supplement a fixed network, but the fixed network still holds the vast majority of subscribers, then the general telecommunications service quality will always depend on the quality of both networks and on the existence of suitable inter-network links. The issue of interconnection will be addressed later in the regulatory section.

3.2 Choice of Technology

The wireless local-loop system is for the most part a simplified version of existing analog or digital cellular technologies.

The advantages of digital cellular technology as opposed to analog will soon become apparent. Digital uses the radio spectrum more efficiently and when there is sufficient quantity to achieve economy of scale, the cost of terminals will be reduced to a level lower even than that of the current analog terminals, albeit this is not likely to be achieved for some years yet.

While analog system uses frequency division techniques, digital cellular systems (especially European systems) uses time division multiple access (TDMA) or code division multiple access (CDMA)technologies. This will help to alleviate congestion in urban area with a high level of call traffic.

In 1982, the Conference of European Posts and Telecommunications Administrations (CEPT) established a group (Groupe Special Mobile---GSM) to study pan-European digital cellular system. It has taken ten years for European public telecom operators to coordinate the implementation of this system Europe-wide--including not only technical but also organizational and political aspects.

In Europe, there are a number of other digital mobile system standards that could be adopted by developing countries as a wireless local loop system --PCN, DECT and CT2-CSI.

Of these, PCN was conceived, in the UK, in order to offer users a real alternative capable of competing directly, in terms of price and quality, with the fixed-link services which are still dominated by British Telecom, although it must be said that it will be some time before this becomes a reality. PCN is based on the GSM standard. The only difference between the two is that the former uses the 1.8 GHz band of the radio spectrum whereas the latter uses the 900 MHz band.

In January this year, the European Telecommunications Standard Institute (ETSI) began to define requirements for wireless local-loop services and recommend suitable technologies, which would enable manufacturers to achieve economy of scale in production, resulting in lower prices for the operators. A working group at ETSI is looking into a range of existing technologies. Since all of the proposed technologies have their shortcomings, the members of the study group will be looking at ways to enhance these technologies or even perhaps to combine the best features of each in order to avoid having to develop new technology from scratch.

A number of other digital cellular standards have been established, in particular in the United States.

On the other hand, the analog cellular system does have the following advantages:

1) Analog systems can be deployed more rapidly than digital cellular.

2) Recent forecasts for analog technology suggest that it will remain cheaper than digital technology until the mid-1990s and even beyond.

3) Analog can potentially provide a much greater area of coverage from a given base station. Digital cells have a maximum radius brought about by transmission delays and the provisions that have been made to equalize them. In GSM this is 35 Km. In analog systems the restrictions are dependent purely on power, antennae, terrain, and propagation conditions rather than intrinsic choices of technology. Cell radii well in excess of 89Km are feasible with analog technology.

4) COCOM still restricts the exportation of some digital cellular related technology. (This might not be the case in the near future.)

Whatever standards are available, the ultimate decision has to be made by individual developing countries to find the solution that is best suited to the circumstances of that particular country.

3.3 Conditions of Service Areas (Disparity between Urban and Rural Areas)

The economics of telephone installation and maintenance favour provision in densely populated areas. Costs are lower and densely populated areas have more (and richer) subscribers who can together offer higher rates of return on investment.

The Maitland Commission concluded that the indicative cost per installed (fixed-link) telephone line in low-density, sparsely populated, rural areas was five times that of the cost per line in urban areas. In addition, the Commission estimated that the subscriber connection cost - that is the cost of the local loop section of the telephone network - was of the order of ten times more for rural areas than urban areas, using technology available in the mid-1980s. Given these factors, the typical situation in a developing country is that telephone provision is considerably poorer in sparsely populated, rural areas than in larger cities and towns.

3.3.1 Radio technology in urban areas

In telecommunications terms, the most important issue that has to be considered in urban areas is the capability of a given technology to handle high levels of traffic. PCN, in the form that has been introduced in the UK with a macro and microcell structure, will be capable of handling the traffic levels expected from residential and mobile users. However, traffic from 'fixed' business users in a highly penetrated market will be well beyond its projected capability, particularly in catering for users situated in multi-floored buildings. In such areas, different provision will have to be made.

Local office-based cordless PBX systems are based on other technologies such as CT2/CAI, and subsequently DECT. It is argued that these technologies (especially DECT) will be better able to handle the very high traffic levels that might be experienced in office applications. Eventually dual standard hand sets should become available and these will allow DECT operation in the workplace and operate elsewhere on PCN. These are not likely to become available until the late 1990s.

However, there is a strong argument that the use of dual standards is not a sensible solution since this may increase the cost of subscriber equipment and possibly reduce overall functionality due to the problems of achieving full interworking. In the developing world, these issues are unlikely to be of immediate importance but may need to be considered where any installed system risks becoming overloaded. This problem is experienced today on fixed-line systems in many urban areas of developing countries.

3.3.2 Radio technology in rural areas

Within any country, whether developed or developing, rural areas present a special problem in terms of how to provide cost effective telecommunications services. While by definition such areas are sparsely populated, they can often be economically important and are often in a position to benefit more from the provision of a suitable telecommunications infrastructure.

In some rural areas in developing countries, the installation of a base station conforming to one of radio-based technologies discussed in this paper can be inappropriate for the users it might serve. In these situations, where subscriber densities are very low and/or distances to the serving exchange are great, the most appropriate solution can be provided, as at present, by a fixed point to multi-point radio system, also using TDMA techniques. There are, however, a number of situations where cellular radio technologies could be considered appropriate. In particular one could highlight the following.

- **Rural regions bordering on conurbations** are suitable for service by multi-access radio system operating primarily within the conurbation. These 'urban-area extensions' are the main example of analog 'rural' cellular networks currently operating in developing countries.

- **Isolated towns or villages** may be suitable for coverage by a small number of analog or digital cells. Alternatively a CT2/CAI system would be suitable with a single village base serving a 200m radius around it. This would require the adoption of a method of alerting users to incoming calls.

- **Scattered users within a relatively close proximity** could be served by a single large analog or digital cell. Disadvantages do exist in the use of cellular radio technology especially in the latter two cases (i.e. 'isolated towns or villages' and 'scattered users within a relatively close proximity'). Cellular radio systems are principally designed to operate in areas with an established trunk infrastructure - to carry the traffic from base station to mobile switching centre. The construction of such a system in an area with a poor infrastructure means that the links between the base stations and the mobile switching centres must also be provided.

The provision of power to cellular or CT2 users is also an important issue. While much of the cost of a fixed-link local loop would be avoided, the possibility of powering remote subscribers 'down the line' is also lost. This means that fixed or mobile users must be able to supply their own power. For mobile users, rechargeable battery power is required, while for remote fixed sites a small solar power or combined energy unit would be needed. The cost of this type of unit will reduce the savings made in infrastructure provision.

3.4 Local Maintenance/ Local Equipment Production

The implementation of radio-based networks in developing countries requires skills which will have to be imported in both the short and medium terms. These technologies require a small number of relatively highly skilled staff, whereas older electromechanical, wired-line technologies require a larger number of staff with a lower average level of skill. This trend applies to all telecommunications systems, whether wireless or wired. It will be for each individual developing nation to determine whether this approach is appropriate to its own circumstances, but there will be some pressure to maximize the efficient utilization of staff with valuable technical skills. For example, there is a risk in many countries of skill drainage due to emigration of skilled telecommunications and computing workers.

The provision of more modern telecommunications systems in developing countries, whether radio-based or fixed-line, will inevitably lead to an increasing level of more highly educated and trained staff. Furthermore, one of the major reasons why radio technologies are likely to become cheaper (in comparison to the wired systems) is because the high labor costs associated with fixed-line local loop can be avoided. This is an area where there is currently a high rate of utilization of unskilled and semi-skilled staff.

In many developing countries there exists a qualified, central core of potential telecommunications staff who can be equipped to use the technologies discussed - this will, however, require appropriate investment in training, over and above the cost of simply establishing the technology.

With regard to the supply of wireless equipment (either fixed or mobile), the option exists for developing countries to produce the equipment locally. While this option may seem attractive, it is important to remember that for the analog and digital cellular technologies discussed so far, the local production of equipment will involve the use of advanced technologies such as VLSI and surface mounting. These require adequate associated local production and would probably be in direct competition with the industries of the newly industrialized countries. As we can see from the experience of countries which have attempted to establish indigenous electrical consumer goods production, it is clear that this type of import substitution is fraught with difficulties, and can often increase the cost to the local consumer. The local assembly of terminal equipment may be more realistic.

4. REGULATORY ISSUES

4.1 What Regulatory Framework?

In the UK as well as in some other developed countries where competition in the telecommunications sector is allowed, regulation is established with the intention of protecting the subscribers' basic interests and nurturing effective competition. In the case of the UK, the general framework is set by the 1984 Telecommunications Act (and its subsequent amendments). Furthermore, individual licenses are granted to operators/service providers which specify the relevant obligations. Although differences may exist in the details, the basic requirements--for emergency service provision, radio spectrum use, and tariff levels--are similar. For a dominant carrier such as British Telecom, universal service provision is mandatory.

In order to implement the wireless local-loop system with some kind of foreign participation, the following steps are necessary:

1) The separation of postal and telecommunications operations
2) The organizational separation of regulatory and operating functions (e.g. creation of independent regulatory bodies to oversee operating functions)
3) The introduction of competition into the basic telephony market

In industrialized countries a government department or agency usually exists which ensures that the telecommunications operators (TOs) will:

- Conform to their license conditions
- Provide a satisfactory level of service
- Respond to customer complaints and problems in a satisfactory manner

In the UK this function is carried out by OFTEL (Office of Telecommunications), which is funded substantially by the license fees levied on all the UK TOs. The size of the fees paid by an individual organization depends on the number of customers and profits made by the organization. OFTEL also has a leading role in the granting of new licenses.

4.2 Allocation of Radio Spectrum

Again, a government department or office will ensure that the operators of wireless local-loop system comply with the radio technical elements of their license, so that they only use those parts of the radio spectrum allocated to them. Failure to carry out these checks could result in interference with other operators or radio users.

In the UK this function is carried out by the Department of Trade and Industry Radio Regulatory Agency. Funding is partially from a radio license fee based on the number of channels allocated and partly by direct grant.

An important element of the successful operation of the radio-based local-loop system is the setting up of a suitable radio regulating organization with the means to ensure radio users to not operate outside their allocated frequencies.

As far as mobile services are concerned, the UK government has imposed an important license condition on the initial cellular operators (Cellnet and Vodafone): "95% of the population had to be covered within 5 years of commencement of operations." This was to ensure that the operators did not choose just to cover the more profitable urban areas and ignore the less profitable rural areas.

In some developing countries where wholly private and possibly foreign companies are licensed to offer wireless local-loop services, it is essential to lay down regulations to protect the population. Besides the "quasi-universal service requirement " mentioned above, there are other important items that should be included in the license given to the operators of wireless local-loop, such as:

- Regulation of network interconnections
- Regulation of tariffs

The wireless local-loop system can be offered by an existing public telecommunications operator (PTO) in a particular country. It is possible, however, for a private company to offer wireless local-loop services. In this case, it is necessary to establish rules in order to interconnect the PTO's network with that of the new company. The extra income the interconnection generates for all providers of network services will make interconnection attractive to all parties. However, if the entire fixed network is poor, then this will have an adverse effect on all inter-network traffic no matter how high the quality of the wireless local-loop service.

4.3 Interconnection

One of the most critical factors when considering interconnection (with WWL systems) is the capability of the fixed network.

In a country where only a single telecommunications operator exists, routing, especially trunk routing, need only as efficient as required for the provision of a good service, and billing is on the whole carried out on a per subscriber basis. As soon as more than one operator is interconnected there are two extra significant requirements:

- Each network must ensure it trunks calls efficiently, ensuring they are passed to each others network at the earliest interconnect point, so keeping their own trunking costs down.

- Facilities for the measuring of call traffic between networks must be made available for inter-network accounting purposes.

This means that there will, at least in the medium term, be a need for some element of modern digital switching at the trunk interconnect level on the fixed network.

Also, guidelines should be drawn by the fixed-network operator(s) as to the method for charging WWL operators in return for providing interconnection. The extra income this should bring to PTOs will make interconnection attractive to all parties. (WLL operators can benefit from better backbone networks in the future.)

5. FINANCIAL ISSUES

5.1 Trends in Technology Costs

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5.1.1 Subscriber Equipment Costs

The ex-factory cost of analog (TACS, NMT and AMPS) subscriber equipment fell by about a half between 1985 and 1992 due to economy gained through large scale production of hand sets. This is the main reason for the particularly steep drop in costs in the early years of operation. The 1990 ex-factory cost of analog cellular hand portable equipment is around $2,000, while that for larger mobile equipment is $1,000.

While the fall in analog subscriber equipment cost will continue although this will be at a slower rate in the future. Volume of production should stabilize and the relevant manufacturing technology advantages will be adopted. The labor cost component for subscriber equipment is now only around 10%, so it is unlikely that further savings can be made in this area. According to one estimate, by 1995, the ex-factory cost of analog hand portable and mobile equipment will fall to $1,600 and $800 respectively.

The cost of digital cellular (such as GSM) handsets are certainly higher than those of the equivalent analog subscriber equipment. This situation is likely to continue until 1996 or 1997 when demand for digital sets is likely to exceed that for analog sets.

5.1.2 Infrastructure Costs and Trends

It is much more difficult to generalize the trends in the cost of setting-up a basic network than for simple consumer goods, such as hand sets. It is important to recognize the following:

- Costs are dependent upon the scale and nature of the network, the type of technology employed, and telecommunications and operating environment where the network is to be implemented.

- The competitive nature of the industry, and the different deals that exist between suppliers and operators, make it difficult to obtain sample prices for the various network hardware and software components until the tendering stage.

Within the UK, a 1990 estimate of the total cost of establishing an analog cellular network, equivalent to that offered by Cellnet or Vodafone was of the order of $1,500-1,600 million. This would serve some 1.5 million users.

However, a more useful guide to the cost of a smaller analog network is the cost of recently installed networks of known size and coverage. Please note, however, that this is the cost of setting up premium mobile cellular networks, as opposed to that for setting up the simpler wireless fixed system.

- A good guide to the rough costs of setting up a small premium, mobile analog network, serving business users, is that of the 9 base stations, single mobile switching centre TACS network set-up a few years ago in Malta. This cost $15 million, based on Ericsson equipment and network links, and was established by a consortium including the UK's Vodafone.

- Nigerian Telecommunications Limited (NITEL) has placed an order with Ericsson for the supply of a TACS cellular mobile telephone system to service the more populous regions of Nigeria including the cities of Lagos, Enuguo and Port Harcourt. The entire contract is worth $41 million.

- The government of Pakistan has awarded two consortia - Paktel and Pakcom - licenses to set up and operate cellular mobile telephone systems. The equipment, worth $35 million, has been supplied by Ericsson.

- Ericsson has also been awarded a $16 million contract to supply an AXE digital switch, base stations and 200 mobile phones to the Hungarian TA/US West cellular joint venture in Hungary. The NMT-450 system started operation in Budapest in December 1990 with a capacity of 1,000 subscribers.

The network costs, for a fully functioning GSM system, as has recently been provided within the UK, is likely to be equivalent to the analog cellular costs, i.e. $1,500-1,600 million for over 80% UK geographical coverage. This system will have an eventual capacity of approximately 2-2.5 million subscribers (in comparison to the 1.5 million supported by an analog cellular system).

5.1.3 Rural Costs

The costs per subscriber associated with providing coverage in less densely populated rural areas will inevitably be higher than densely populated urban areas because of a number of factors, which include:

- Lower number of subscribers supportable per base station.

- Longer distance between base station controller/mobile switching centre links, and the associated increased costs of providing redundancy.

- Provision required to protect equipment against often harsher environmental conditions.

- Extra provisions often required to back-up unreliable power supplies.

The exact balance of these costs and chosen technology will depend on the area in question.

Given the large coverage area which can be serviced by cellular-based technology, cellular phone systems are less onerous to set up and operate than land-based telephone systems providing the same coverage. The fact remains, however, that in absolute terms, very substantial capital investment is still necessary.

In a fixed-link system, construction includes tasks such as digging trenches and installing poles which can be performed relatively cheaply by indigenous semi-skilled labor. However, setting up a cellular telephone system relies almost wholly on highly-skilled personnel, who can be in short supply in developing countries. This expertise, not to mention the equipment, might have to be imported. All this means is that the construction of a cellular telephone system is likely to be more expensive in a developing country than in a developed country. It also means that more of the money used to provide radio-based network services will be spent outside the country concerned than is the case with a fixed link network. From this point of view, wireless is not the best option for developing countries.

5.2 How to obtain financing

Broadly speaking, there are four sources of capital available to nations interested in radio-based technologies.

These are:

1) Any capital generated from profits on the existing activities of the national telecommunications administration and retained within the organization for reinvestment;

2) Capital raised from within the country, possibly through the issue of shares in a new telecommunications venture, or in the existing telecommunications administration,

3) Capital obtained by encouraging the entry of foreign investment through a joint venture, the sale of part of the telecommunications administration or by offering a telecommunications license to an appropriate foreign company; and

4) Capital gained via the appropriate use of resources borrowed or granted from suitable aid agencies.

In the past, borrowing from commercial banks would also have been a possibility but, given the current high level of debt in many developing countries, this no longer seems as attractive as an option. Again, as the situation in each individual developing countries will vary widely, no hard and fast rules for the raising of capital can be set down. Options 1) and 4) would perhaps be preferable where the aim is to improve the public switched network.

6. Conclusion

As examined so far from several perspectives, wireless local-loop is just another system that has to be implemented under the constraints currently faced by various developing countries. However, there are definite advantages to WWL over electromechanical fixed-links. It is the hope of all concerned that these advantages are utilize to their fullest.

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Wireless Local Telephone Service: Lessons For Effective Implementation

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Wireless basic telephone service networks are gaining acceptance worldwide as a cost-effective, high-quality, rapidly deployable method of providing much needed voice, data and facsimile communications. The experiences of carriers and governments currently using this approach hold valuable lessons for those considering a wireless telephone service program.

The December 1984 Report of the Independent Commission for Worldwide Telecommunications Development "The Missing Link" cited several key characteristics of the then current state of telecommunications:

- The vast majority of the telephones in the world were concentrated in a relatively few number of countries. The disparity between industrialized and developing nations existed despite the fact that telecommunications is taken for granted as a key factor in economic, commercial, social and cultural activity in industrialized nations and as an engine of growth, while most developing nations have systems that are inadequate to sustain even essential services.

- An expanded world telecommunications network would benefit both developing and industrialized countries. The process of improving and expanding networks in developing countries will create a major market for telecommunications equipment. A more comprehensive world system will increase international traffic to the advantage of the operators. Where information flows so does commerce. More world trade and other contacts will increase understanding. An expanded telecommunications network will make the world a better and safer place.

- Telecommunications play an essential role in emergency and health services, commerce and other economic activity, in public administration, and in reducing the need to travel. There is moreover a clear link between investment in telecommunications and economic growth.

- The economic and social benefits an efficient telecommunications system confers on a community or a nation can be clearly perceived. The system can also be used as a channel for education, for disseminating information, encouraging self-reliance, strengthening the social fabric and sense of national identity, and contributing to political stability.

The situation of ten years ago remains essentially the same. If anything, the value of telecommunications from a social, economic and political standpoint is even more strongly perceived today. Thus, the challenge is clear - find and implement a communications technology solution that provides service providers and users practical, reliable and cost-effective voice and data communications. Since 1984, the rate of technological change has continued to accelerate and various telecommunications service approaches have been tried with varying degrees of success. One such approach that is being given ever-increasing attention is the use of wireless technologies, in particular cellular-type systems, to provide basic telephone service.

It is well established that the largest component of any telephone network cost is incurred in the deployment and maintenance of the local loop or "last mile". Twisted-pair, copper wire technology used since the invention of the telephone more than 100 hundred years ago has remained essentially unchanged. Using standard copper wire in the local loop demands extensive network planning and capital commitments well in advance of demand and it is not economical for many service environments. By using existing cellular technology and a specially designed cellular subscriber unit, much needed voice, data and facsimile service can quickly and cost-effectively be provided without the cost or complications of wire facilities. [See Figure 1]

The purpose of this paper is to examine the various experiences of Postal, Telephone and Telegraph ministries ("PTTs") and cellular service providers ("CSPs") in Europe, Latin America and Asia that are utilizing wireless telecommunications technologies for the deployment of basic telephone service infrastructures. I will focus on the following key areas:

- Factors involved in the decision making process used in the evaluation and selection of a wireless approach;
- The regulatory schemes adopted by governments to encourage or ensure timely deployment of the wireless basic telephone network;
- Experiences of PTTs and CSPs operating wireless basic telephone networks and issues requiring special attention;
- Discussion of possible future technological developments which may impact the nature of wireless local telephone service deployment; and,
- Summary of key success factors for wireless local telephone service programs based on a combination of approaches.

The Decision Making Process

Any decision making process is normally composed of interplay between various stakeholders with often disparate objectives. The implementation of wireless basic telephone service programs has been no exception. An assessment of the programs implemented in several countries reveals some underlying similarities and helps to establish a basic framework for evaluating future country-specific programs. Those similarities include:

- Fundamental lack of telecommunications infrastructure and significant pent-up demand for basic telephone service, especially among small businesses;
- Constrained capital availability to fund the implementation of telecommunications network deployment, especially outside urban centers;
- Strong advocacy of telecommunications as driver of economic growth by political interests. This has included emergence of political reformists who chose telecommunications as a key issue to garner populist support based on unfulfilled promises for significant improvement;
- General social unrest within sectors of the population either directly or indirectly linked to availability of telecommunications service;
- Implementation of privatization initiatives for PTTs to secure general treasury windfalls from private interests, gain access to capital and management resources for infrastructure programs and establish definitive performance criteria to ease social pressures; and,
- Licensing of mobile cellular networks based on success of wireless technology in other parts of the world and strong interest of private consortia in owning and operating cellular networks.

The timing and specific interactions of these different factors has varied, but the result has been consistent: creation of an environment where wireless basic telephone service has been able to establish itself as a viable and attractive service option. Several observations concerning the privatization initiatives and the cellular licensing process also serve to shape our overall assessment framework.

Privatization and/or cellular licensing does not necessarily provide sufficient operator incentive to pursue widespread telecommunications infrastructure programs, regardless of technology being deployed. The financial planning horizons of, and extent of competitive pressures on, the service providers are significant factors in all cases. For example, if the service provider has a short financial return horizon, then the investment decisions it makes for network deployment and operation may lead to unsatisfactory performance from a social and political perspective.

The financial planning horizon is a function of the perceived relative risk of the investment in terms of license duration and protection, political stability, overall economic performance, capital repatriation, currency stability and competitive positioning as well as other factors. These factors are constantly being reassessed. Favorable risk environments usually lead to more aggressive investment decisions which in turn yield broader infrastructure gains and positive socio-economic gains. Conversely, negative risk factors result in more conservative investment strategies, smaller infrastructure gains and continuation of the socio-economic pressures.

CSPs are a case in point. Cellular licensees have enjoyed unparalleled success in virtually every country worldwide. The CSPs have benefitted from a cellular system's ability to provide high quality voice communications very rapidly. In most instances, cellular service is a substitute for, or alternative to, the traditional telephone network. Cellular flourishes because the regular telephone network is often viewed as antiquated, unreliable or unavailable. This success has come despite the often premium prices (in relation to regular telephone service) charged for the "mobile" service. The role of cellular as a communications tool for many thousands of users is a very positive one, but still leaves essential telephone service out of the reach of many thousands more due to the high prices of the service.

Regulatory Approaches

As noted above, competitive positioning is a major risk factor impacting a service provider's financial planning horizon. Regulatory oversight is often appropriately used as a substitute for competitive market pressures. Thus, the balance between market protection and competitive and/or regulatory pressure can significantly impact investment decisions. The difficulty arises where competition is being interjected into a market, like the telecommunications market, that is inherently capital-intensive to serve and in its infancy in terms of established distribution channels and market penetration. Yet, many countries are undergoing just such a market transition. Consequently, the role of the communications ministries/ regulators in establishing the policies and rules governing the telecommunications industry is critical.

The challenge of regulation is to serve as a proxy for competitive market forces without impeding the introduction of true market forces where most appropriate. Regulators also find themselves in the role of social welfare directors in terms of attempting to advance the broader social agenda of "universal service". "Universal service" does not necessarily mean a telephone for everyone, but it usually does mean access to reliable telephone service on some reasonable basis. This may mean access to affordably priced public telephones or calling centers as well as measurable progress towards some long-term service target (perhaps measured in terms of telephone lines per hundred people).

This social agenda is often in direct conflict with a competitive market environment. Service providers concentrate their resources in areas that promise the greatest financial return. For telecommunications service providers, the clear incentive is to serve the business community in the urban areas since it is that segment of the market that generates a disproportionate share of all revenues and is the least costly to serve in terms of capital investment. By way of example, it is estimated that in most developed telecommunications environments, only 5% of all business users account for approximately 50% of business revenues. Further, the cost per access line for this market segment tends to be very low, approximately $500, due to the geographic concentration of the users in urban centers. As competition is added to the market, the competitors also seek to address this lucrative market segment resulting in a further concentration of services in urban areas. This is the economic reality of a competitive marketplace. Scarce financial and management resources will be focused where the greatest return can be realized in the shortest time period.

A review of the various countries where wireless local telephone service programs either have, or have not, been implemented shows that there appear to be three primary regulatory models that have developed over the last several years for communications industry structuring. The three models are 1) the modified competitive model; 2) the single provider model; and, 3) the dual purpose model. The characteristics of each is presented below.

The modified competitive model is characterized by:

- o Aggressive movement toward competitive service provisioning is most sectors of the telecommunications industry;
- o Privatization of the PTT has been pursued or is being considered. If the PTT has been privatized, there is often a service exclusion period for the new "owners" that is intended to allow near monopolistic market conditions for selected service segments in exchange for investment considerations;
- o Cellular licenses have been granted to multiple providers with the PTT/local exchange carrier ("LEC") involved in one or more of the licenses; and,
- o The service providers pay fees to the government based on gross revenues or a pre-established payment plan.

The single provider model is characterized by:

- Little movement toward competitive service provisioning in vital sectors of the telecommunications industry;
- Privatization of the PTT has not been pursued, but may be considered. Monopolistic market conditions exist and the regulator and service provider are often the same entity;
- Cellular license has been granted with the PTT involved in the license. Outside third parties may be partners in the cellular license based on capital and management resource requirements; and,
- The PTT budget is part of overall government fiscal budget. Expenditures and revenue sharing is controlled by the government. Cellular service providers pay fees to the government based on gross revenues or a pre-established payment plan.

The dual purpose model can have the characteristics of either the modified competitive model or the single provider model with the following key distinctions:

- Keen political recognition of disparate service gap between dense urban areas and less dense suburban and rural areas. May also include basic dissatisfaction with rate of network expansion overall;
- Separate cellular-type license(s) issued or being considered for wireless local telephone service programs through third party investors or business community co-operatives. Conditions of the licensing usually require service commitments over defined time periods in exchange for a service exclusion period and interconnection commitments;
- The PTT/local exchange carrier ("LEC") may be involved in one or more of the licenses; and,
- The service providers pay fees to the government based on gross revenues or a pre-established payment plan.

For purposes of this discussion, the key issue is the extent to which a given regulatory model encourages the implementation of basic telephone services in a country. The situation facing many countries (i.e., low telephone penetration and lack of capital resources) has created an environment that requires creative solutions to attract and maintain investors. Each country faces a unique set of factors which influence the specific regulatory structuring being pursued, however, the trend in recent months appears to be toward adoption of the dual purpose model by governments for the following reasons:

- The economic and operational benefits of wireless basic telephone service have gained wide-spread acceptance;
- Generally compatible with virtually any market environment since it targets basic telephone service needs and allows, if deemed appropriate, the PTT/LEC to remain involved;
- Accelerates the provision of basic telephone service for businesses and residential customers in areas outside the core urban areas;
- Allows distinction between value-added mobile services and basic telephone service, while giving CSPs options to expand service offerings;
- Provides access to additional capital and management resources to address the local telephone service program; and,
- Increases the competitive environment which generally accelerates all aspects of the telecommunications marketplace as carriers seek to capture market share.

Regulators also have control over the most important component of any wireless basic service program: radio spectrum. Without an assignment of an appropriate amount and frequency of radio spectrum, wireless service is obviously not possible. In some situations, regulators are beginning to require cellular licensees to commit some portion of their network capacity to providing basic wireless telephone service or public access services. This public service commitment is viewed as a trade-off for allowing the CSP the right to participate in the more lucrative mobile service markets. Similarly, for entities that are making a commitment to providing wireless basic telephone service, regulators are often granting concessions for public switched telephone network ("PSTN") interconnection and international long distance gateway service. These concessions make the wireless basic service program more financially attractive and tend to make the overall marketplace more competitive.

A discussion of the variables impacting the assignment of spectrum is beyond this paper, but will be addressed

FIGURE 1

Wireless Local Loop Design

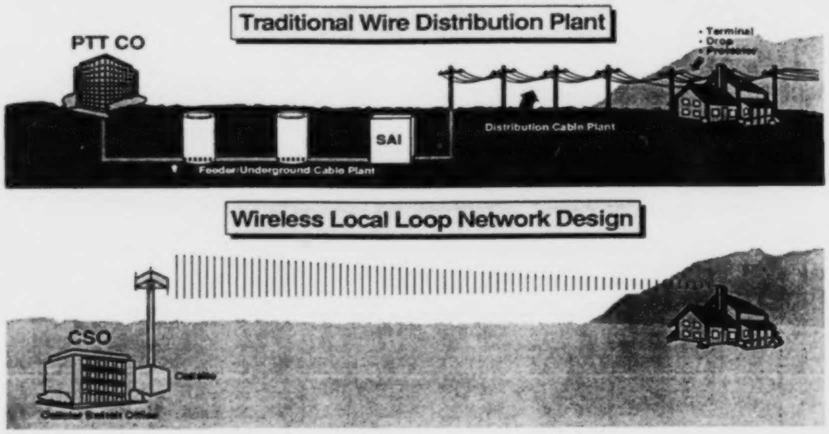
Traditional Wire Distribution Plant
PTT CO
• Terminal
• Drop
• Protector
SAI
Distribution Cable Plant
Feeder/Underground Cable Plant
Wireless Local Loop Network Design
CSO
Cell site
Cellular Switch Office

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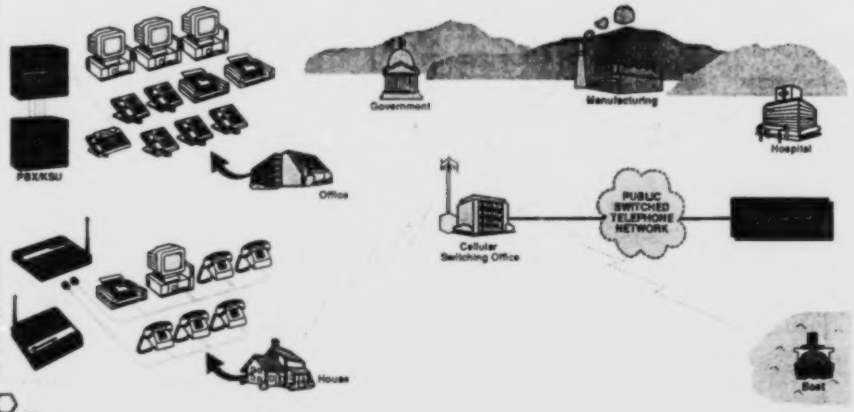
FIGURE 2

Typical Fixed Cellular Network


Government
Manufacturing
Hospital
PBX/KSU
Office
Cellular Switching Office
PUBLIC SWITCHED TELEPHONE NETWORK
House
Boat

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in terms of current technology available to implement a wireless basic telephone service program.

Wireless Basic Telephone Service Programs

Currently, large-scale fixed cellular deployment solutions for basic telephone service [See Figure 2] are being pursued or considered by government-owned telephone companies and private CSPs in countries such as Argentina, Brazil, Germany, Indonesia, India, Malaysia, Philippines, South Africa, Spain, Venezuela and others. Smaller-scale programs by private companies are underway in many other locations around the world. These programs are driven by the fundamental underlying economic and operational advantages of cellular technology. These advantages include:

- Rapid deployment capability to meet pent-up demand and high growth areas. Depending on system size, implementation can be as quick as a few weeks for a small system capable of serving a couple of thousand users. The capacity of current cellular technologies allows servicing hundreds of thousands of customers within relative small geographic areas;
- Lower initial and ongoing capital costs per subscriber served, especially in sparsely populated or difficult-to-serve terrain. Capital costs, depending on the technology standard deployed (i.e., AMPS/DAMPS, ETACS or GSM), range from under US$1,000 to approximately US$2,000 per customer served regardless of distance from the cell site within the coverage area and those costs are expected to continue to decline in the future;
- Excellent network expandability characteristics which allow both small and large capacity expansions in a timely and cost-effective manner. This is especially true with the introduction of new digital radio technologies such as time division multiple access ("TDMA") and code division multiple access ("CDMA") within cellular standards;
- Reduced maintenance and operating costs per subscriber served with annual savings estimated to be approximately 50% as compared to traditional wired facilities;
- Simplified network planning since only broad coverage areas and busy-hour calling characteristics need be identified for wireless service versus detailed routing schemes and growth plans for traditional wired facilities. Wired facilities must be sized to meet demand as far as 10 years in the future due to the high cost of placing distribution plant. Thus, the operator does not receive a return on that investment until customers are added;
- State-of-the-art technology and service capability which offers customers the latest custom calling features in addition to "plain old telephone service". Wireless networks can be designed with a grade of service comparable to wired networks for both voice and data communications needs;
- Suitable for temporary and permanent service situations due to compatibility with wired networks to allow future service migration if wired facilities are deemed appropriate. Even if used as a temporary service solution, wireless may serve as a emergency back-up/alternative line recovery solution for wired facilities; and,
- Configurable as either a totally wireless local service offering or a joint mobile/fixed service offering.

Clearly, fixed cellular is the wireless solution to many everyday communications needs. The range of applications which can be served are nearly as varied as the customers who implement them. Virtually every major industry segment has begun using fixed cellular solutions for some aspect of their business, including:

- Basic local, intra-country and international long-distance voice, data and facsimile service;
- Supervisory control and data acquisition;
- Security alarm monitoring;
- Public access cellular payphones and calling centers; and,
- Disaster recovery and emergency back-up circuits.

Today's fixed cellular subscriber equipment technology is designed to allow timely, economic and transparent integration of a wireless solution with existing telephone equipment. Transparent integration means that there is no need for special training or operating instructions. Users simply place and receive calls as if the service were provided by a regular telephone company. Installation of the subscriber equipment can be as easy as plugging the fixed cellular unit into a power outlet and connecting the customer's telephone, facsimile or other telephone device through standard connectors. Fixed cellular subscriber equipment is generally comprised of four basic elements: 1) cellular transceiver; 2) intelligent interface; 3) power supply; and, 4) an enclosure.

Fixed cellular subscriber equipment has many advantages over regular cellular terminals. These advantages include the ability to serve multiple extensions over hundreds of feet apart, true "telephone line" functionality for data and facsimile communications due to optimized circuitry and intelligent interface technology, availability in a wide array of product configurations (including cellular payphones) for virtually any service need or environment, enhanced quality due to better antenna options and avoidance of signal fading and high quality power supplies and battery back-up to ensure operational integrity.

The results of the programs implemented to date are that customers are very satisfied with the service and value that it has brought to them in terms of enhanced quality of life, increased productivity in work environments, and versatility for meeting a variety of voice, data and facsimile communications needs. A major application of small business users, who are early adoptors of fixed cellular service and key drivers of economic growth in any country, has been for facsimile communications [See Figure 3]. Thus, the importance of data communications capability in the network is critical, but the transmission speed only needs to be 9.6 Kbps to accommodate the majority of user requirements.

Another major consideration in any wireless telephone service program is the pricing associated with the service. Pricing programs have ranged from flat rate calling plans that are the same as local telephone tariff structures to modified flat rates that give an allowance of call usage per month and then charge per minute rates for calls over the pre-established limit. Other carriers have maintained per minute calling charges which are either the same as normal mobile cellular rates or at some discount (30% to 50%) to mobile service rates.

If the service provider is offering mobile service as well as fixed cellular service, it usually attempts to distinguish the wireless basic service offering(s) from mobile service to allow alternative pricing schedules. There is a growing practice by service providers of establishing special wireless local telephone service tariffs that are significantly less expensive than standard mobile rates for qualified installations (e.g., fixed cellular) or applications (e.g., a dedicated facsimile line or data monitoring program). This encourages fixed cellular, wireless basic service while avoiding alienation of the mobile subscribers who continue to pay premium rates.

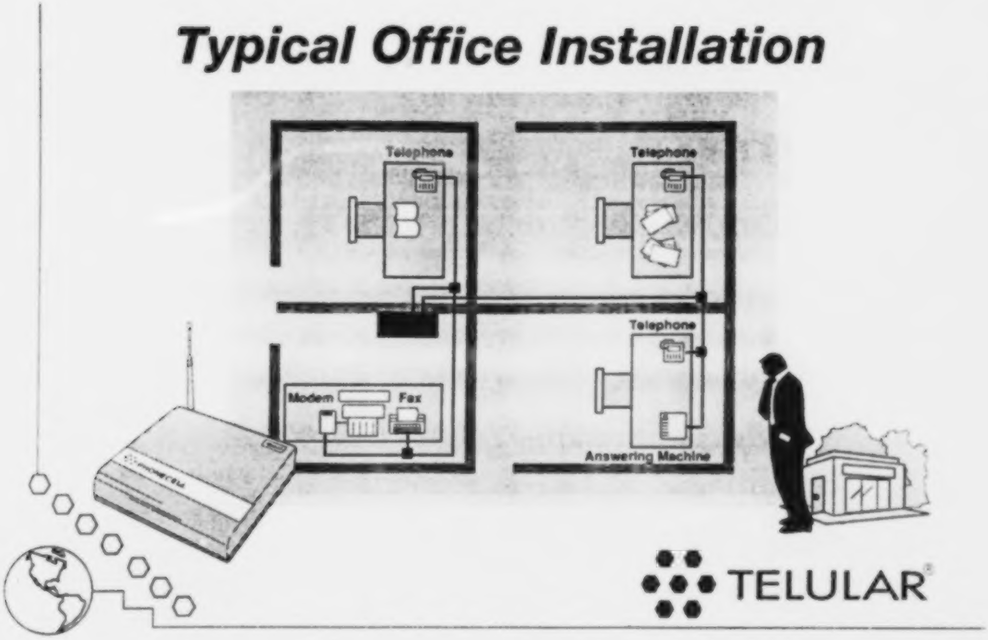
In some instances, the fixed cellular customer terminal equipment is considered to be part of the network by the service provider and given to the subscribers. This method has been used by PTTs who view wireless radio service as simply a replacement for the outside plant investment and choose to charge standard telephone rates for the service. The issue of whether or not customers are required to pay a service initiation fee is generally handled in accordance with previous practices of the PTT/LEC.

As CSPs and wireless local exchange companies ("WLECs") consider implementing wireless basic telephone service programs, several key operational and network configuration issues need to be carefully assessed. The assessment process should examine the potential user applications, customer needs and perceptions, pricing plans, distribution channels and sales compensation structures, sales training requirements, product configurations and specifications, technical support requirements, network design criteria, billing and administrative support issues, regulatory issues, potential strategic partnerships (i.e., manufacturers, interexchange carriers and local interconnect companies), and other relevant issues.

The experience of carriers who have implemented wireless basic telephone service programs using cellular-type technology indicates the most critical issues relate to system capacity and signal coverage. The demand placed on the network is essentially the same as a traditional telephone network. Users do not distinguish between the wireless versus wired link, unless pricing programs are implemented to create user awareness. Thus, average user busy-hour calling levels approach .045 and .075 erlangs for residential and business customers, respectively.

Another factor worth noting is that the network can be more precisely designed if the normal "mobile/ roamer" service is not allowed within the customer base. If mobile customers are allowed, then care should be taken to differentiate the service offerings in terms of the type of subscriber equipment allowed to be used on the network. In some instances, service providers are implementing networks that do not have the standard cellular system "hand-off" software that transfers telephone

FIGURE 3



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conversations from cell site to cell site. This is done to limit the mobile capabilities and has been included by some regulatory authorities as a condition of a wireless local service license.

Cellular infrastructure manufacturers have introduced special network configurations specifically designed for wireless local service programs. These special configurations have been designed to work in conjunction with standard telephone company central offices or with small, digital private automated branch exchanges ("PABXs"). When so configured, the cost per subscriber served is significantly reduced since cellular switch costs are largely avoided.

The types of cellular systems being utilized for fixed cellular, wireless basic telephone service programs include every standard currently available: AMPS, NMT, ETACS and GSM. All of the systems, except for the GSM networks, utilize analog radio technology. The AMPS standard is the most widely deployed technology in the world, accounting for approximately 60% of all cellular subscribers, and consequently enjoys manufacturing economies that make it an attractive technology for wireless telephone service programs. In addition, the manufacturers are introducing digital radio capability for the AMPS networks that should significantly enhance network capacity, lower overall cost per customer served and improve the inherent security of the customers' communications. Few digital AMPS ("DAMPS") systems have been implemented anywhere in the world even for mobile usage. One reason for the limited digital transition is the lack of data transmission standards currently implemented in the standard and general resistance of mobile users to adopt the DAMPS portable phones due to higher unit cost and bulkier size relative to analog phones.

GSM systems are being widely adopted for mobile service, but have several limitations in terms of their usefulness in wireless basic telephone networks. The limitations relate to the high cost of terminal equipment and need for extensive network intelligence to support the system. The cost of terminal equipment will decline over time as manufacturers increase production to meet demand in maturing GSM markets.

Fixed cellular, wireless basic telephone service programs are by their nature designed to bring service to the broadest possible market areas, both geographically and in terms of customer segments. Initial system deployments have generally been structured around the concept of attaining the largest possible signal coverage "foot-print" and then supplementing coverage through the use of cellular signal extenders and strategic cell site additions. Cellular system capacity, as previously mentioned, is easily expanded and system size is a function of demand and capital availability.

Cellular is a line-of-sight technology which means that great care needs to be taken during deployment of subscriber terminals to ensure that signal reception is of sufficient quality to allow trouble-free communications. The majority of customer service inquiries arising from fixed cellular, wireless basic telephone service programs have been traced to improper installation (power, grounding and inside wiring) and antenna placement at the customer location. This concern has been effectively addressed by the CSPs and WLECs through training programs for the technical personnel and use of appropriate installation test equipment.

As mentioned previously, the terms and conditions of wireless network interconnection to the PSTN is a significant determining factor for initial and ongoing success of any wireless basic telephone service program. The ability of wireless telephone users to call, or be called from, users on the regular telephone network requires a high degree of technical and operational cooperation between service providers. If these providers view each other as competitors, then the incentive exists to impede the other provider's network deployment by refusing or delaying interconnection, charging excessive amounts for the service, and/or providing inferior technical performance in the interconnection circuits. Regulators need to be aware of these issues and establish fair, reasonably priced and mutually beneficial interconnection structures. As mentioned, many CSPs and WLECs are requiring that interconnection terms and conditions be included as part of the license to ensure favorable treatment.

Summary

Wireless basic telephone networks hold tremendous promise for delivering the missing link for many countries struggling to provide essential voice, data and facsimile communications services to business and residential customers. Customers want timely deployment of high quality service at reasonable rates and wireless networks are capable of meeting those needs. Proper regulatory structuring can greatly assist the process and make the program financially attractive to potential third party providers. The structures that appear to be enjoying the greatest success are the following:

- Special wireless local service licenses which are separate from mobile service licenses and PTT/LEC service programs. The licenses generally have a "franchise" exclusion period or territory as well as PSTN interconnection and international gateway service concessions.

- Programs that use of analog AMPS technology for infrastructure deployment with provisions made to allow transition to digital radio transmission as the economies of such technology warrants the change. This implies allocation of appropriate spectrum frequencies and capacity for the program.

- Programs that allow focus on both business and residential service target markets with flexibility to provide public access services, as appropriate. The programs should have service pricing structures that allow appropriate rates of return on investment over reason-able investment horizons, yet ensure that the service is avail-able to the largest possible number of customers.

- Programs that take advantage of strategic relationships between manufacturers, financial institutions, and local business interests. Consideration of rural telephone co-operative programs may be warranted to gain rapid deployment in smaller, isolated markets.

While adoption of a program that has the characteristics noted above does not ensure that wireless basic telephone service will be extended to all of the customers who would like to receive service, it should provide a critical additional source of telecommunications service. The extent that wireless technologies will play in the long-term development of basic telephone service in developing countries remains to be seen, however, all indications are that the role will be increasingly significant over time.

Forging New Links-
Developing Virtual Learning Environments

Strategic Plan for Information Technology

Dr. Philip J. Bossert, Assistant Superintendent

Hawaii State Department of Education
Office of Information and Telecommunication Services
Honolulu, USA

Appropriate access to voice, data and video information systems for every public school student, teacher and administrator regardless of their location or learning environment by the year 2000 - the Superintendent's information technology vision for the DOE is part and parcel of the organizational vision he has articulated for the future of education in Hawaii's public schools. This PTC strand will present the Department's vision for information technology and the implementation of the vision.

PLANNING FOR INFORMATION TECHNOLOGY

Information Technology Trends in Education

Information and telecommunication technologies are evolving and changing so rapidly that any attempt to describe the "current state of the art" in any area of these technologies will find itself outdated almost before the ink is dry on the paper. There are certain overall trends, however, which seem to characterize the current arena of information and telecommunication technologies as they apply to learning environments.

Faster, Smaller, Cheaper

The processing speed of computers doubles every two or three years. The 256,000 byte memory chip which cost $120 last year is replaced this year with a 1,000,000 byte (one megabyte) chip which costs $40; and this will be replaced next year with a 4 megabyte or a 16 megabyte chip which will soon cost less than $25. Fifty megabyte and 256 megabyte chips are already being fabricated in small quantities and one gigabyte (a billion characters) memory chips have been designed.

The $10 million super computing mainframe that filled an air-conditioned room in the early 1980's was replaced by a $100,000 minicomputer in a closet in the late 1980's, and then by a $1,000 desktop microcomputer with twice the power or a $150 gameboard with better sound and graphics in the 1990's. Hardwired "dumb" terminals slaved to a single central processor in the 1980's are being replaced by intelligent wireless digital assistants and electronic agents which function as "clients" to a wide variety of "server hosts" located almost anywhere in the world.

Color television receivers are worn as watches or eyeglasses, and full-motion color video is available over normal telephone lines. There was more on-board computing power in the micro-controllers and sensors installed in the 1990 Buick than was available on the first Apollo moon lander. Cameras are made as one-use, throw-away cardboard boxes or unlimited-use electronic "XapShot" imaging devices. And twenty volume encyclopedias with stereo sound, color movies and hundreds of pictures now come on a single CD-ROM disk that can be produced for about $1.50 each.

A ten year old child can have more information and telecommunication technology in his bedroom in 1993 than the Pentagon had available to it in 1972. Voice, data and video technology for a classroom costs less than a complete set of football gear, and the only reason the team has new uniforms this year but the teacher is still using chalk on a blackboard in the classroom is that most of us are still setting our priorities according to industrial age paradigms.

Decentralization

Smaller, faster, cheaper, microchip-based voice, data and video devices are empowering individual users at their desks, in their homes and in their cars. This personal digital power is resulting in thousands of "declarations of independence" from the control and constraints of centralized computing systems, data centers, entertainment centers, shopping centers, and a host of other types of "centers." Mainframe-based applications are being "downsized" to run on clustered minicomputers or local area networked microcomputers.

Mainframes are capital investments which take a long time to depreciate and which require considerable care and feeding in secure and controlled environments to function properly. Microcomputers are quickly becoming disposable commodities which you can pick up at the local drug store. Microchips allow our greeting cards to play happy birthday for us, answer our telephone with our voice when we are not there, watch the baby in the crib, tell us when the roast is done, and keep the kids occupied for hours with high action video games in stereo sound and color animation or intelligent and challenging education programs which talk to them.

Wireless LANs, Ethernet over cable, fiber to the home, personal communications systems — more than ever before, there is no reason for Mohammed to go to the mountain for information when that mountain of information can be brought to him anytime, anyplace and anyway he (or she) chooses.

Networking

The two previous trends toward microchip-empowered end users working in decentralized information environments is fueling a third trend toward resource networking. Once end users get over the initial feeling of empowerment that comes from mastering their own microcomputer, VCR or Karaoke machine, they quickly realize how much more information there is to be had "out there." Just by adding a data modem to the microcomputer, a fax machine to the telephone, and a satellite dish or cable hookup to the television set, we gain access to an almost limitless source of data and information.

Although it takes a little bit of time and, in many cases, a solid credit card account, individual users can log into public networks and information channels in audio, video and data formats to gain access to and share thousands of information databases. Experienced "neuromancers" are able to "ride" electronic networks for hours the way most of us ride highways in our cars; they can find almost any type of information from almost any type of resource.

Installing something as simple as electronic mail on a local area network in your school or office can improve productivity many times over by reducing paperwork and file storage, eliminating telephone tag and committee meetings, and reducing the time lag of mission critical information. Link together several local E-mail networks at different sites around town or around the country into a wide area network and you save on travel time and expense to boot. The cost of these networks may seem very expensive until you add up the cost of the time and space most offices lose communicating by phone, paper, and face-to-face meetings which require travel time and parking.

Integration

In the past — and, in most parts of the world, still today — telephones used copper wires; computers used coaxial cables; and video used the airwaves. That has all changed as information and telecommunication systems and services have all become increasingly digital in format. You can use your TV as a computer monitor or you can watch TV in a window on your computer. You can use your phone to access digital audio voice mail, to transmit data packets, or receive video conferencing signals. Telephone wire — twisted pairs — used to be limited to 2400 bits/second for data transmission, but then the transmission engineers got it up to 9600 and then 19,200 bits/second for their modems. Then Integrated Services Digital Networks (ISDN) came along and the telephone engineers pushed the rates up to 56,000 and 64,000 bits/second. The computer folks kicked the copper transmission rates up further yet to 10,000,000 and then 16,000,000 bits/second so they could run Ethernet and TokenRing networks over twisted pair. And recently announced breakthroughs to 100,000,000 bit/second digital traffic over those twisted pair wires may give us a "video dial tone" the way we get audio and data dial tones now from our telephones and fax machines.

Software packages are using the same integration strategies, adding more and more features to every program. Word processing software comes with a built-in spreadsheet and drawing function, while the newest spreadsheet programs have draw and word processing programs integrated with them. The new data/fax/voicemail modems now available for less than $350 allow your computer to talk to other computers, send and receive faxes, and answer your telephone as a sophisticated answering machine. In the fall of 1992 a microprocessor-based device for less than $7,000 was announced which incorporated into a single unit: 1) a Intel 486-class microcomputer with 8 megabytes of memory, a 350 megabyte hard drive, and a color monitor; 2) a laser printer; 3) a laser scanner; 4) a fax machine; 5) a laser copying machine; and 6) a data modem! Standing in line to use the copier, the fax or the printer will soon find the same end that sharing the office microcomputer did.

This trend toward integration is made possible because the newer computers are faster and more powerful enabling them to run more complex software programs. This increased complexity and integration offset one another by allowing hardware and software systems to be more intelligent and helpful in dealing with us as users. Today's programs and equipment offer context-sensitive, on-line help and training using spoken words, animated graphics and interactive, CD-ROM-based video demonstrations. And the newest VCRs and microcomputers (such as Apple's Centris 660av — for less than $2,000!) allow you to talk to these digital assistants (and they to talk to you) using plain English commands to tape a TV program or fax a document.

Global Context and Personal Focus

CNN brings the problems and promises of the world to our living rooms; and then demands that we do something about it. It was somehow easier to deal with the world when the biggest issue was telling the neighbor next door to stop yelling at his kids. We now know more than we care to about the personal and professional lives of political candidates thanks to radio, TV and print coverage; and this makes it all the more difficult to decide how to vote. An increasingly large number of Americans are so overwhelmed, confused, intimidated or irritated by this that they just don't vote at all.

The local area network E-mail system that we use to send a memo to the boss and a lesson plan to the teacher down the hall also links us with a few keystrokes into the Internet or the National Research & Education Network (NREN) where we get to read abstracts of articles in the University of Colorado library, use a super computer in New Jersey, or try out our Russian with a colleague in Moscow.

The State of Technology in Hawaii's Learning Environments

These trends in information and telecommunication technology are disturbingly bifurcated. On the one hand, they allow the "techno-literate" among us to log into the world's voice, data and video networks and go ecstatic reveling in the richness of their resources and information. On the other hand, the information overloaded and overcommunicated environments that are created as a result of these trends deny increasing numbers of the "techno-peasants" of our societies access to and participation in our schools, communities and workplaces and force them to turn technology-poor or data-numbed to drugs, alcohol and/or violence to pass the empty time of a highly stimulated and data-rich, but value-desperate life.

And, of course, it is the job of the schools to deal with this situation — both sides of it!

Although there are a few impressive technological highlights in the 50th State's learning environments — such as the distance learning networks developed by the University, the DOE and Hawaii Public Television — Hawaii's public schools are, for the most part, technologically impoverished and the majority of its teachers and administrators so swamped with paperwork and bureaucracy that they have little time left to familiarize themselves with the new technologies which might rescue them from some of this drudgery. And when these students, teachers and administrators leave our schools, they can walk into any Sears, Longs, or Safeway at the nearest shopping mall and buy for less than a week's salary almost any electronic information and telecommunication device their heart desires. The amount of money and time which the DOE — and the State of Hawaii as a whole — spend on controlling the acquisition and use of information and telecommunication technologies would, if reallocated, buy a lot of additional technology and training for the public schools.

The Department of Education is struggling to keep up with a growing student population — 2,500 to 3,000 additional students each year, not counting a growing adult education population — and, at the same time, to bring its outmoded facilities up to date and up to specification. The DOE's Office of Business Services estimates that the cost of providing new schools and additional classrooms, while renovating a majority of the existing ones, will exceed $2.2 billion over the next ten years. In light of these staggering cost projections and the constantly shifting demands of education in the 21st Century, perhaps we need to rethink the questions we are asking rather than focusing all of our efforts only upon trying to find answers to the same old questions. Perhaps the question is no longer, "What is the role of technology in the classroom?" but instead, "What is the role of the classroom in the emerging era of information technology?"

We hear that an increasing number of our children are "at risk" in our educational systems. It does not take too much imagination or research to fundamentally change our view of this problem — the proverbial "paradigm shift" — and see that it is perhaps the schools which are at risk — at risk of being places which are unlike anyplace else our students see in their lives and at risk of being mostly foreign to any other experiences they have in their daily lives. Given the highly visual and graphical environments in which most of our current students have been raised and currently live, we must ask ourselves if the school facilities we provide and the teaching methods we employ are still effective? Are still relevant? Or are even resident in the same frames of consciousness most of today's students inhabit? Visiting some of Hawaii's public schools is akin to visiting Williamsburg, Virginia; it is a nice place to visit and historically interesting, but most of us would not like to live, work or learn there on a daily basis.

A Vision for Information Technology in the DOE

Voice, data and video to every public school classroom by the year 2000! In a sentence, this is the basic vision for information technology expressed by Superintendent Charles Toguchi. More specifically, the Superintendent's goal is to provide appropriate access to voice, data and video information systems for every public school student, teacher and administrator regardless of their location or learning environment. The key phrases here are "appropriate access" and "regardless of location or learning environment."

The role of information and telecommunication systems and services in the Department of Education (DOE) is to enhance student and staff learning, increase intellectual and administrative productivity, and improve academic and administrative effectiveness. To accomplish this, the DOE's information technologies must:

- Ensure *equity of access* to information resources to all persons involved in learning in the State of Hawaii. The DOE's information and telecommunication systems and services must provide access to the learning resources required for life-long learning to all of Hawaii's citizens regardless of their age, sex, race, language skill, physical and mental ability, or geographical location.
- Ensure *ubiquitous access* to the DOE's information and telecommunication systems and services from anyplace at any time. Just as banking became a 24-hour operation with the introduction of automated teller machines, so too must education become a 24-hour opportunity accessible from a variety of locations — school, office, home — via a multitude of voice, data and video devices.
- Ensure *coordinated and integrated access* to the DOE's information and telecommunication systems and services so that "public information resources" are easily, readily and cost

effectively available to everyone, while "privacy and personal information" are carefully protected.

Just as life-long learning means that education does not stop just because one has graduated from high school or college, so too does it mean that learning does not stop once a person steps outside of the classroom. The vision for information technology in the DOE must indeed include access to a telephone, a computing device, a video receiver and a telecommunication link in every office and classroom. But this vision must also provide as much as possible for access to information resources via telephone, television and linked microcomputing devices from the home, the field and places of business.

This vision for information technology which empowers students, teachers and administrators in their classrooms, offices and homes is in complete harmony with and provides support for both the DOE's School Community Based Management (SCBM) restructuring effort and Project Ke 'Au Hou administrative reorganization project. The decentralization of resources and responsibilities requires increased access to computing and communication technology to support the accountability which goes along with this effort. The "flattening" of the organizational hierarchy to streamline workflow must be accompanied by improved information systems, electronic assistants and telecommunication links to support and, in some cases, to replace the "human" systems, assistants and links which now exist.

SCBM and Ke 'Au Hou are restructuring the resources of the DOE. Just as these efforts require "enabling political legislation" so too do they require enabling information technologies. One will not succeed without the other. Introducing a new organizational structure into a system but keeping the old ways of processing and communicating information will result in the failure of the restructuring; the old information technologies will eventually "in-form" the new structures with the old processes and ultimately nothing will have changed except the veneer. By the same token, attempting to introduce new information technologies into a system without adopting new organizational and workflow structures will doom the successful implementation of the new technology; the new technologies will not process work "the old ways" very efficiently, will appear difficult to use in support of the old organizational structures, and will eventually be abandoned.

The Superintendent's information technology vision for the DOE is part and parcel of the organizational vision he has articulated for the future of education in Hawaii's public schools. It is neither a trivial task nor an inexpensive effort. To do it right — *appropriate access to voice, data and video information systems for every public school student, teacher and administrator regardless of their location or learning environment by the year 2000* — will consume six to eight years and an estimated $250 million to implement for Hawaii's 180,000 K-12 students; 110,000 adult and community education students; 13,000 teachers; and 4,000 administrative and clerical staff. The costs of not doing it — and doing it right — are likely to be three to five times higher in terms of financial costs to Hawaii's future economy and immeasurable in terms of the human costs to Hawaii's future citizens.

IMPLEMENTATION STRATEGIES FOR INFORMATION TECHNOLOGY

The *Strategic Plan for Information Technology* provides the strategic level vision, goals and objectives for the Department's educational technology initiatives and, as such, serves as an overall framework for the evolution of the Department's operational plans for the implementation of information and telecommunication systems and services in the classrooms and offices of Hawaii's public schools. Currently, many different groups at the state, district and school levels are working collaboratively to implement Superintendent Toguchi's vision.

The following sections provide an overview of the specific efforts of these various groups to implement in an integrated and coordinated manner both the technology *infrastructure* (voice, data & video LANs and WANs) and the educational *applications* (electronic systems and services) which transit and inhabit that infrastructure. On the **infrastructure** side, more than half of the Department's 240 schools either have already implemented or are currently at some stage of planning or installing local area voice, video and data networks which will link more than 10,000 classrooms and offices statewide. The state and district level technology support teams are assisting the individual schools and offices in this local area networking effort while, at the same time, they are designing and implementing an integrated, digital, high speed, wide area voice, data and video network to tie together these 300 plus LANs.

On the **application** side of the ledger, the Department's award winning instructional television and distance learning services reach into almost every classroom and home in the State. In addition, an expanding number of electronic services such as Internet access, E-mail, on-line library & media booking services, and electronic document & workflow management are moving from controlled lab testing and pilot project environments out onto the networks and into the schools, offices, and homes of students, teachers and administrators as production systems. Each of these areas is discussed in more detail in the following pages. Not discussed here, but of equal importance to the success of the whole picture, are the multi-media curriculum development projects and the integrated, client/server-based school information systems being implemented on these same networks to support the instructional, student, financial, and personnel information needs of the Department.

The Infrastructure:
WAN & LAN - Voice, Video, Data

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The Network Services Branch is responsible for the telephone, television, and data networks in the Department of Education. Through its infrastucture planning and deployment, the Branch is positioning the Department for a future high speed network that delivers ubiquitous voice, video and data access to every K-12 educational environment in the State.

INTRODUCTION

The Network Services Branch in the Office of Information and Telecommunication Services maintains, plans, implements and supports telecommunication services in the Department of Education and seeks to provide an integrated voice, video, and data "information utility" to schools and offices. The current status of the DOE network is that 95% of the schools are wired for cable TV; the DOE has a statewide protocol independent telecommunications data network linking all schools and offices; and the DOE's state and district offices are connected with the State's Centrex phone service.

This branch is responsible for the operation and maintenance of the current network, planning and upgrading the wide area network (WAN), providing consultation for school and office local area networks (LAN) and upgrading the phone systems in the schools. In its efforts to develop the network infrastructure for the Department, Network Services has established standards, policies and procedures for the telecommunications systems.

The Department of Education (DOE) is embarking on the building of an electronic highway that will serve the needs of students, teachers, and staff well into the 21st century. Superintendent Toguchi has stated his goal for technology as "voice, data and video to every public school classroom by the year 2000". The goal of the Network Services Branch is to build an intelligent network with structured wiring using accepted industry standards that will serve the administrative and instructional needs of the users in the DOE.

PRESENT WIDE AREA NETWORK (WAN)

The Department of Education has in place a statewide protocol independent, telecommunications network that connects 240 schools and 50 district and state offices throughout the state to the IBM mainframe computer host at the State's Data Center at the Information & Communications Services Division (ICSD) of the Department of Budget and Finance and to the VAX system in the DOE Data Center. This Wide Area Network (WAN) connects every school and office in the DOE in the following configuration:

- The mainframe computer site at ICSD is connected to the district offices on the islands of Hawaii, Maui, and Kauai through the State's HAwaii Wide Area Integrated Information Access Network (HAWAIIAN) Microwave backbone.
- The ICSD Data Center is connected to the DOE's Data Center by SONET.
- The hub sites and DOE Information Technology Centers (ITCs) on Oahu are connected to the DOE's Data Center via 56 KB (DS-0) digital circuits leased from Hawaiian Telephone Company. The Honolulu District ITC is connected directly to the IBM host via a 56 KB digital circuit.
- Some of the ITCs on the neighbor islands are connected to the island's State Offices via 56 KB digital circuits leased from Hawaiian Telephone Company.
- Most of the schools and offices on Oahu are linked to the hub sites or to the DOE's Data Center via 9600 analog circuits leased from Hawaiian Telephone Company.

- Some of the ITCs on the neighbor islands are connected to the island's State Offices via 56 KB digital circuits leased from Hawaiian Telephone Company.
- Most of the schools and offices on Oahu are linked to the hub sites or to the DOE's Data Center via 9600 analog circuits leased from Hawaiian Telephone Company.
- All neighbor island schools are linked to the neighbor islands' State Offices via 9600 analog circuits leased from Hawaiian Telephone Company.

The Timeplex Timepath equipment used are protocol independent remote line concentrators that allow utilization of the same network infrastructure regardless of the computer communication protocols of the host computers. The remote line concentrators utilize the bandwidth efficiently by the application of demand driven network architecture.

The remote sites on the network have remote line concentrators with at least 4 ports installed in an 8 or 16 port chassis. The Department's Financial Management System (FMS) uses one port, accessed through SDLC protocol, and one or more ports are used for accessing applications run on the VAX computers, using an ASYNC protocol. An automatic self-healing capability is provided on the network through redundant links.

PLANS FOR WAN UPGRADE

The goals of the upgraded WAN are to provide the schools with the capability to access resources on remote LANs through the statewide network and to access outside resources such as Internet. The network will provide accessibility to NREN, HREN and other outside information providers. Timely access to the DOE host and distributed computing resources will be provided to the schools through the upgraded network.

The DOE has started upgrading its WAN to a high speed digital network. The present analog lines will be converted to digital links. The network upgrade will be implemented in a phases bringing schools and offices into the upgraded network as schools install LANs and as funds are available for the upgrade.

The need for upgrading the existing network is being driven by:

- the DOE computing direction toward client/server applications. Existing systems, such as the Financial Management System, are to be modified to client/server computing. Systems like the Data Warehouse for information access are being built for client/server access.
- the expansion of LANs in DOE. A LAN based E-mail system is being implemented for all DOE sites for messaging capabilities within the DOE and for connection with E-mail systems outside of the DOE. A Workflow Automation System based on LANs is being planned for statewide implementation.
- the internetworking requirements of DOE applications. Limited bandwidth in the current network has prohibited some applications from utilizing the statewide network. School library systems are based on LANs that require internetworking. All DOE schools and offices will install LANs at their sites. Internetworking LANs between all sites in the DOE on a peer-to-peer basis and providing access to resources on host and distributed computers will be required.
- multimedia and imaging, are emerging technologies on LANs. The DOE will be utilizing these new technologies in the near future for various applications.

The upgraded network will provide scalable network bandwidth to accommodate the applications that will require high bandwidth in the future. The DOE will be in position to migrate to broadband networking technologies with high speed cell-switching architecture over the upgraded WAN.

FUTURE PLANS FOR THE WAN

The State is in the process of installing an Institutional Network (I–NET) on Oahu. The DOE is working with ICSD to connect strategic DOE sites to the I-Net backbone, which will provide sufficient bandwidth for video, voice, imaging and data.

The new enhanced network will provide internetworking of LANS at all sites in the network, based on the TCP/IP protocol. Any node in the network, including computer hosts and hub sites, will be addressable from any other node. Schools and offices will be able to access the central and distributed host computer resources, access other schools' LANs, send E-mail, transfer files between the schools' LANs, etc. The internetworking will further provide access to the Internet network outside the DOE's network.

Routers (with options for bridging) will be installed and used at all sites in the network to accomplish the internetworking. Utilizing routing and bridging functions integrated into other communications technologies will also be considered.

LOCAL AREA NETWORKS

The Network Services Branch has developed a standard LAN design for schools to follow in planning and installing their LANs. The design criteria for the standard LAN design are:

- standards based
- scalable
- able to support future high speed protocols
- able to support separate LANs for administration and curriculum.

The standard LAN design for a school is based on 10baseT Ethernet. 10baseT Ethernet is a star topology where each node is connected separately through twisted pair cable to a central hub. The standard design calls for level 5 unshielded twisted pair (UTP) cabling connecting the workstations in the classrooms to intelligent hubs located in a communications closet. The hubs are Simple Network Management Protocol (SNMP) manageable, either locally or remotely. The hubs are connected to a fiber optic backbone that connects all of the buildings on campus.

Level 5 UTP cable is specified because it will support the current 10 megabit per second speed of Ethernet and can be used for higher speed protocols in the future, such as CDDI, and 100 megabit per second Ethernet. The limiting factor for 10baseT cabling is the 100 meter maximum distance allowed between a node and the hub.

Multimode fiber optic cable is specified for the backbone connection between buildings because it can carry the Ethernet signal up to 2 km without a repeater. It will also support higher speed protocols such as FDDI, 100 megabit Ethernet, and ATM. In the future the fiber optic cable will be used to deliver voice, data and video signals.

There will be dedicated LAN servers for each LAN. The various server platforms, such as Novell, UNIX, Windows-NT etc. will be evaluated. The client workstations can be any combination of Macintosh, Windows, OS/2, or DOS workstations. The LAN operating system should be capable of being managed remotely from a central location.

The selection of network operating systems is based on the DOE's functional requirements for a LAN operating system. These requirements include high performance, high reliability and stability, adherence to standards, openness and easy connectivity, ease of administration, remote network management, flexibility and expandability, ease of learning and use, security and data protection, product support, and future adaptability.

The Network Services Branch works with the schools in planning and implementing their LANs. The branch presents the standard LAN design and works with the school to match the school's particular layout and networking needs to the design. Schools are aided in their identification of conduits for cabling, hub site selection, and cost estimation for cabling installation. In conjunction with the Network Services Branch, the schools develop a detailed networking plan for their campuses. They are assisted in contacting cabling contractors to wire the schools for LANs. Usually, telephone cabling is pulled to the classroom along with the UTP cable for the LAN. If the video cable in the school needs to be upgraded, it is recommended that this be done at the same time as the other cabling.

VIDEO

Presently, 95% of the schools have a cable drop but many classrooms are not wired for video. The DOE plans to wire every classroom for closed circuit as well as cable TV reception. TV origination sites are planned for every district in the state with broadcast and teleconferencing capability.

Desktop video conferencing through both Local Area Networks and the Wide Area Network is being explored.

During the transition, while voice, data, and video networks are being consolidated into the Network Services Branch, the Distance Learning Technology section has been responsible for developing the video infrastructure. Details on the video infrastructure are included in the Distance Learning Technology paper.

VOICE

Telephone, or voice services, are presently available in administrative offices both at the schools and districts. Additional B-1 lines have been installed by the schools as required by their programs. The DOE telephone replacement project goals are:

- Install Hybrid/PBX systems in all high schools statewide, to serve as hubs for each complex, where voice mail services can be provided cost effectively.
- Replace present obsolete key systems and electromechanical systems in elementary and intermediate schools with electronic key systems, with voice mail capability as well as computer accessibility, sized to accommodate a phone in every classroom.
- Provide toll-free voice services throughout the DOE by connecting to the State's microwave network.

- Provide connectivity to each building Intermediate Distribution Frame (IDF) so schools will be able to wire each classroom as funds become available.

CONCLUSION

Although the present infrastructure requires that voice, data, and video have separate access mechanisms from the origination site to the carrier-based WAN, the DOE envisions a migration to a fiber-based Asynchronous Transfer Mode (ATM) technology by the end of the century. In preparation for this, a hierarchical star topology is recommended for campus wiring with level 5 twisted pair within the buildings and a fiber optic backbone between buildings. When the day arrives when it will be feasible to do so, the DOE schools will be prepared to consolidate all three media via ATM switching.

DISTANCE LEARNING TECHNOLOGY

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Hawaii's Distance Learning Program was initiated to meet the needs of a geographically isolated island state with 238 schools spread across seven islands. The majority of the state's population, 80%, resides on the island of Oahu, with the remaining 20% distributed across six islands. Two of the islands have a single school site. The goal of the Distance Learning Program is to provide equal educational opportunities for all of its constituents, regardless of where they live in Hawaii.

INTRODUCTION

When Hawaii started its distance learning program five years ago, we quickly realized that our schools could not subscribe to satellite-based services from the mainland United States. Geographical and time zone difficulties precluded our schools from receiving courses transmitted via satellites. Hawaii is located too far west to receive many of the mainland satellite signals. In addition, the state is two time zones away from the West Coast and five time zones away from the East Coast. A further complication is the fact that Hawaii does not implement daylight savings time. So, 10:00 a.m. in California would be 7:00 a.m. in September, but 8:00 a.m. in November.

THE TECHNOLOGY

Since satellite technology was not a cost effective alternative, other technologies were explored. Hawaii's distance learning programs rely on several different technologies: microwave, ITFS, cable television, telephone, and computer data lines. The Hawaii Interactive Television System (HITS) is a point to point microwave system that is used to transmit the signals between the islands. HITS then uses an omni-directional microwave signal on ITFS (Instructional Television Fixed Services) frequencies on the various islands. These ITFS signals are either picked up directly by the schools or by one of the seven cablevision companies across the state. The cablevision companies carry the programming over the public access channels at no cost to the Department of Education (DOE).

Currently, the video network described above reaches 97% of the students, teachers, and administrators in the DOE. The cablevision companies, as part of their franchise agreement, provide cable drops to almost all of our schools; the DOE installs campus wiring to the classrooms.

In order to implement the distance learning program, there was a need to enable students to interact directly with the studio teacher. To provide this interaction, a distance learning telephone line was installed in every school. In many schools, this one line supports several extensions, enabling students from various classrooms to talk directly to the instructor. Toll free 800 lines were installed in the studio so schools would not incur long distance charges. For the high school courses, a fax machine was provided for sending and receiving tests and homework assignments. A toll free 800 phone line was also installed in the instructor's home, allowing students to get help with their homework after school.

Initially, the DOE's distance learning program was completely dependent upon the University of Hawaii's HITS television classrooms. Now, the DOE has two studios from which its programming can be originated for transmission across the state. The studio at Maui High School originates the Advanced Placement Calculus course and the Homework Hotline. The second studio in the Liliuokalani State Office building serves two purposes. It originates a number of live programs as well as broadcasts Board of Education meetings. A central control room coordinates the transmission of full bandwidth televisions signals via a fiber optic Institutional Network (I-Net) as well as compressed video (T-1).

I-Net is a network established by the cablevision companies as part of their franchise agreements with the State of Hawaii. It is cooperatively run by the Cable Access Division of the Department of Commerce and Consumer Affairs, Information Communications Services Division of the Budget and Finance Office, University of Hawaii and the Department of K-12 Education. This allows both video and data networks on the various islands.

The compressed video signals (T-1) are transmitted from CODECs over the HAWAIIAN microwave WAN across the state.

Future expansion includes building a combination distance learning studio/video conference center in each of the DOE's seven districts. These studio/vcc will be networked/connected via both the I-Net and the HAWAIIAN WAN wherever possible. Sites outside of these two networks will be connected by Hawaiian Telephone (GTE). Students, teachers, and administrators can then be networked to participate in presentations, demonstrations, meetings, and courses or workshops without regard to geographic location.

THE PROGRAMMING

Hawaii's distance learning program delivers over 80 hours of live, interactive programming statewide per month. The programming continues to benefit from the DOE's partnerships with the Hawaii Interactive Television System (HITS), the University of Hawaii, and Hawaii's seven cablevision companies (listing)

Over 95% of our programming is live and interactive. The programs fall into three categories: students, educators, and general public.

Student Programs

These programs share the expertise and services that are not generally available at individual schools. The first course offered in Hawaii's distance learning program, Advanced Placement Calculus, was offered for schools that did not have the enrollment for a full class. Other programs brought experts in fields such as science or music to the classroom or to students' homes after school. Imagine the excitement of participating in conversations with astronauts on the space shuttle or navigators on the voyaging canoe, Hokulea. The following is a brief description of the student programs:

Advance Placement Calculus is provided to schools that do not have enough students to offer this course or for schools that cannot find a teacher to teach AP Calculus. This was our first distance learning program and is now in its fourth year. The course follows the AP Calculus syllabus and is taught by Koki Tamashiro originating from the Maui High School studio. Mr. Tamashiro was a Milken Scholarship winner last year. This interactive course utilizes fax machines at each site and a toll free 800 number for students to contact Mr. Tamashiro after school hours for help with their homework.

KidScience is a hands-on science program for fifth and sixth grade students. Students across the state collect data, do experiments, and share information with the teleschool teacher, Patty Miller. Over 535 classrooms with 15,000 students take part in this program. In November 1993 the United States Distance Learning Association awarded KidScience first place recognition as the Distance Learning Program for K-12 education.

The Music Factory provides half an hour of high quality, fast paced, instruction on all parts and types of music for fourth grade students. During the second half hour, students participate in a live interactive lesson, participating in activities and asking questions of music instructor Cheryl Toma Sanders.

Exploring The Islands is a cooperative program between the DOE and the Moanalua Gardens foundation. Fourth graders learn about the environment of the state of Hawaii from various environmentalists.

Homework Hotline is offered in all levels of mathematics two afternoons a week. Students are able to call in an discuss their problems with Mr. Tamashiro. The problems are worked out by Mr. Tamashiro and the students for all to learn. Students from fourth grade through adults in GED programs call in for help.

Teens and Technology (TNT) is a semi-monthly program scheduled after school for students to learn what other teenagers are doing with technology. Mrs. Ellen Miyasato (Honolulu District's Technology Resource Teacher) along with students from Dole Intermediate host the program.

Science Cookbook is a late afternoon bi-weekly program for students interested in science. They can watch fun, safe and educational science activities, and ask questions on various topics of master science teacher, Randy Scoville, and his guest scientists.

Student Videos provides an opportunity for schools and students to air their video productions statewide. These taped programs are a welcome supplement to our ensemble of interactive programs. Any student or teacher can submit a project for airing. The purpose of this program is to share with the community at large what the future cinematographers are able to produce.

DOE Specials have time blocks designed to provide an hour of various topics of current interest. These are usually one time live programs where students throughout the state can ask questions of the guest presenter(s). This year's specials have included topics and guests such as:

- Sharks
- Videotex Training For Students
- Senator Inouye
- Senator Akaka
- Ocean Safety
- Solar Car Vehicle Construction
- Pulama Ika Wai (Cherish the Water)
- Voyage of the Hokulea
- Hokulea and the Space Shuttle
- Saving the Environment
- Endangered Species
- Tracking The Sharks
- Hurricanes - One Year Later
- Sea Life Park - Ocean Pollution
- Coast Guard - Oil Spills

Teacher Training Programs

The one certainty in our schools is change. Teachers and administrators need access to staff development courses and workshops to continually develop their skills and knowledge. Distance learning provides a valuable alternative to staff development, particularly to those teachers and administrators who live in the more remote areas of our state. Distance learning allows them to participate in inservice training and other staff development activities from their schools or their homes. Courses offered include:

- Student Behavior, What Can I Do?
- Using Microsoft Works (had over 1200 enrolled)
- Think Science
- Making the Connection: LAN, WAN, MAN
- Distance Learning Technologies
- English as a Second Language
- Networking
- Living With The Arts
- Keeping Up With Video In The Classroom
- Technology and Telecommunications
- Every Child Can Succeed
- Students At Risk
- RISE: Training for Special Education Teachers

Community Interest Programs

In addition to programming for students and DOE employees, the Department also provides programs that are of interest to the general public. Many educators find that the programs are of interest to them, too. The community interest programs allow the DOE to share information and obtain feedback on issues and concerns relating to schools. These include:

Focus on Education is a weekly "forum style" program with four separate themes, which are rotated weekly:

> ***Priority 1*** discusses critical issues facing the Department of Education. The public is given an opportunity to hear from and ask questions of guests such as: Board of Education Members, the Superintendent and his administrators, principals, teachers and many others.
>
> ***Tech Info*** helps keep the educators and the community abreast of the latest developments in technology as it relates to the classroom. New technology is demonstrated along with clips of what various schools are actually doing with technology.
>
> ***Wassup*** "talks story" with students and adults about issues concerning students. Each program has students giving their views and answering questions called in by other students.
>
> ***Community Specials*** is an opportunity for various community agencies and groups to share their educational programs with the educators, students, parents and general public.

Point of View is a monthly program designed for educators and sponsored by professional associations. Some of the different groups that have presented programs include: Hawaii State Teachers' Association, Parents Teachers Students' Association, Parent Community Network Council, EdTech.

Adult Education programs are sponsored by various Community Schools for Adults. These are high interest subjects such as: Financial Planning, Silver Legislature, Conversational Hawaiian, Computer Basics I & II, Income Tax Preparation, Construction Law.

THE FUTURE

The future for distance learning in Hawaii is unlimited. The implementation of new technologies and the expansion of existing ones continue to expand the capabilities of the DOE's technology infrastructure.

For example, the DOE is considering a pilot project in conjunction with the University of Hawaii and GTE Hawaiian Telephone to deliver T-1 compressed video to eight sites across the state. This will allow two way video and audio for teacher inservice programs and student courses. Some of these sites are not serviced by our existing video network.

As cablevision companies increase the number of channels, more programs can be accommodated. The DOE is currently involved in a pilot project with Oceanic Cablevision to connect six sites on Oahu to support "classroom studio" sites for originating programming.

The distance learning program strives to deliver equal educational opportunities for all learners, both children and adults, regardless of where they live in the state of Hawaii.

National and International Network Services for Distance Education (NINSDE)

Sharen Arakaki, Hawaii State Department of Education
Jodi-Ann Chu, University of Hawaii Computing Center

Honolulu, USA

NINSDE is being developed to meet the information needs in the K-12 environment of the State of Hawaii Department of Education (DOE). Access to electronic resources provide powerful educational tools that can greatly enhance teaching and learning. To date, access by the DOE K-12 users is limited by minimal equipment, applications, and teacher training. Through NINSDE, full Internet access has been made available to the students and teachers in the classrooms of the selected pilot volunteers.

INTRODUCTION

For over five years, teachers and students have used a DOE statewide electronic mail system for information exchange and enhanced learning. The Distance Learning Technology electronic mail (DLT mail) and Hawaii CALLS (HICALLS) systems brought an array of interest from the students.

An explosion of learning projects flooded the systems which limited access to classroom accounts and private teacher accounts. Students demanded more access to electronic mail projects. Hawaii's students wanted current information and the ability to exchange with other students on a global context. With the world being bombarded with information, teachers and parents wanted to maintain the attention of students without limiting them to electronic mail.

OBJECTIVES

The students' needs were met by legislative funding to provide national and international network services for distance education. This project, NINSDE, sought to:

- design a user-friendly interface to access Internet services
- establish policies and procedures
- create a "Train-the-Trainers" cadre to test the new service and develop training modules
- support the development of a client/server model for Internet to the desktop
- evaluate the cost-effectiveness of Internet connectivity for K-12.

PARTNERSHIP

DOE sought and developed a partnership with the University of Hawaii's Computing Center (UHCC). UHCC currently has a T-1 connection to the NASA Ames Research Center (NASA Science Internet). Using the distance learning telephone line (B-1), students are able to dial into the Hawaii FYI gateway with a maximum 9.6 KB connection to the UH gateway (UH Starmaster II) and a subsequent 56 KB connection to Kalama (SUN SPARCserver10). It is through Kalama that the pilot group can gain access to the Internet (see Figure 1).

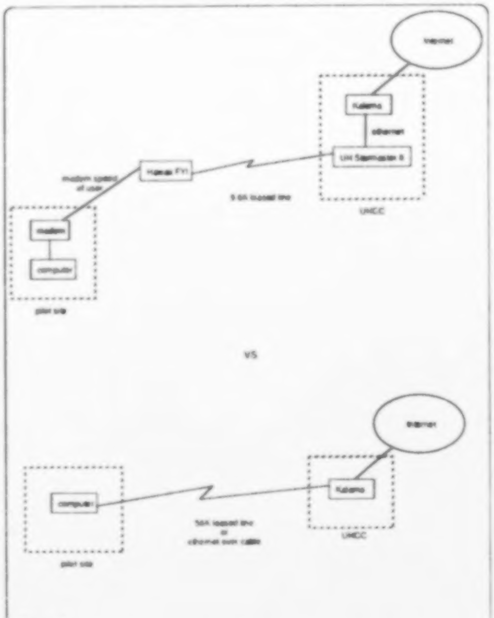

Figure 1

Utilizing UHCC's expertise in developing the Unix-based interface and their T-1 connection into the physical T-3 backbone infrastructure [created by the National Information Infrastructure (NII)], DOE gets a connection for a fraction of the cost. The partnership is a cost-effective test environment for the DOE. It has allowed for faster installation and implementation along with immediate and full access to Internet resources by the K-12 pilot group.

Without this partnership, the DOE would need to lease its own physical link to the continental United States. A T-1 link costs approximately $200,000 per year. For this project, it makes economic sense for the DOE to use the UHCC connection. UHCC, in return, has a perfect control group to test the operating system and menu structure. Prior to a UHCC upgrade of its operating system, it is necessary to test this new operating system on a control group. At the onset of the pilot, the user was required to know the Unix operating system and environment to "login." During the implementation of the project, UHCC was able to create a simplified interface. UHCC plans to migrate to a graphical user interface (GUI) for their future users.

TRAINING

If Internet resources are to meet its potential as a K-12 educational resource, teachers must learn how to effectively use them as a teaching and learning tool. Teachers in the pilot found appropriate resources from the Internet and adapted their traditional method of conducting the lessons to design an effective "instructional design model" learning environment. To expand the use of electronic resources, both teacher in-service and student team training workshops are being offered by the pilot teachers.

A call for teacher volunteers to participate in a summer course was solicited over the current electronic mail systems. This informal request prompted teachers to investigate other innovative, instructional tools to integrate into their current teaching environment.

There was a flood of volunteers for the NINSDE pilot project. Thirty-five experienced classroom teachers who had been using on-line services such as E-mail were selected for the project. "Observation on Electronic Networks," the summer training, in June of 1993 required 48 hours at the UHCC lab and 48 hours on-line. The overall objectives of the training was to:

- understand the Internet
- create a server appropriate for K-12 with a user-friendly menu
- identify/utilize on-line resources to incorporate into existing lesson plans.

CLASSROOM SUPPORT

Students, second through twelfth grade, as well as their teachers are participating in this pilot. They represent each of the seven districts statewide. Students and teachers in this "progressive" teaching environment are fortunate to have a defined network of support and a strong desire to implement telecommunications into the classroom.

With a project that enables global access, support dedicated to essential areas such as rebuilding lesson plans, providing technical connectivity and establishing policies must be provided. From this project, three areas have already been established to accommodate such support: site librarians and colleagues, technology coordinators, and administrators.

This pilot will be evaluated in may of 1994. To date, students have participated in Virtual Vacations, a lesson asking students to describe their ideal vacation. Via the UHCC connection, students in Hawaii were able to connect with students from various locations in the world and compare assignments. A class of juniors were able to calculate and create models from measurements of planet features to scale. In another class project using on-line technology, students all around the world gathered and compared data on water quality. And yet another use of the connection allowed Hawaii's students to track the Antarctica R.O.V.E.R. as well as follow the daily journals of the scientists directly involved.

NETWORK CONNECTIVITY & HARDWARE

The NINSDE pilot project has developed a server with a prototype menu system which provides K-12 access to appropriate K-12 resources. Kalama, located at the UHCC, has 128 RAM and is upgradeable to a 512 MB memory (8 slots, 64 MB each), disk storage upgradeable to 26 GB (currently using 10 MB) and six access ports through Hawaii FYI X.25 gateway. A Gopher structure is also being built to accommodate access from other K-12 institutions and will serve as a model to the DOE's schools. The Gopher will store and disseminate information on newly designed lessons which utilizes on-line research, calls for participation and provides specific project plans.

THE FUTURE

NINSDE is just one of the many applications that has come to fruition in the race to access information in the global context with a personal focus. As the teachers become more comfortable with computers and the telecommunications environment, their endless questions and needs will become more sophisticated and obtainable. We have just begun to research the most frequently asked question: "Can a cost-effective, user-friendly interface accessing multimedia information be developed?" This question instigated research to bring the Internet directly to the desktop. It is a goal that requires more participation by all levels of the educational community and its partners. For now, it is economically sensible to make full use of this connectivity and research software such as Turbo Gopher, The GUIDE, InterNews and CU-SEE Me to meet the expanding needs of the user.

CONCLUSION

The DOE-UHCC partnership has provided the temporary connection upon which the DOE has begun building its own on-ramp to the future superhighway. Through continued partnerships, administrative support, legislative support and financial assistance, this temporary roadway can evolve into a direct connection for the State of Hawaii Department of Education to global on-line resources. With the department's vision for information technology, educators and students are empowered to forge new links in the development of virtual learning environments.

Making The Connection - EMail/LAN Pilot Project

Vicki Kajioka and Kerry Koide

Hawaii State Department of Education
Office of Information and Telecommunication Services
Advanced Technology Research
Honolulu, USA

What are the benefits of electronic mail on local area networks? Advanced Technology Research conducted the EMail/LAN Pilot Project to test site-based E-mail on local area networks (LANs) linked throughout the State of Hawaii. This paper discusses the implementation and results of this pilot project.

Advanced Technology Research (ATR) researches and disseminates information on new and emerging technologies that support the instructional and administrative operations of the Department of Education (DOE). The section provides technical consultation on the implementation of new technologies and coordinates the development of strategic plans for improving the DOE's use of existing and emerging technologies.

This section is responsible for developing pilot projects to test and evaluate information and telecommunication technologies, coordinating grants, negotiating partnerships, and promoting research in applying new technologies for information processing and communication support. In carrying out these responsibilities, ATR's two major projects are the "EMail/LAN Pilot Project," the subject of this paper and "National and International Network Services for K-12" (NINS), the subject of the next paper. The rationale for two electronic mail pilot projects is that the EMail/LAN is targeted for teachers and administrators while NINS for K-12 is targeted for students.

INTRODUCTION

Just as the telephone revolutionized voice communications, electronic mail is revolutionizing data communications. During the 1992-93 school year, the Department of Education adopted local area network (LAN) based electronic mail (E-mail) systems linked through the DOE Wide Area Network (WAN) to implement the Superintendent's vision of *voice, data and video to every public school classroom by the year 2000!* Using the E-mail system, teachers were able to exchange lesson plans, collaborate on projects and lessons with other classes, send messages to their administrators, and send homework assignments to students.

OBJECTIVES

The EMail/LAN Pilot Project tested site-based E-mail on local area networks (LANs) linked throughout the state. The objectives of the project were to:

1) plan, design, and install local area networks

2) evaluate electronic mail on school local area networks

3) establish the routing of messages between the school LANS

4 test the mail-enabled feature of Microsoft software (i.e. Works, Word, Power Point)

5) identify instructional and administrative activities using E-mail.

THE PILOT

In May of 1992, seven pilot schools were selected for the project. The selection criteria included district recommendations, school readiness to assume project responsibilities, and representation across grade levels and districts. The schools were Kalaheo Elementary in Kauai District, Ka'ala Elementary in Central District, Leihoku Elementary in Leeward District, Ben Parker Elementary in Windward District, Koko Head Elementary in Honolulu District, Baldwin High in Maui District, and Hilo Intermediate in Hawaii District. Six of the schools used Macintosh computers; the one DOS site was Koko Head Elementary School. (See Figure 1 for an example of a Macintosh school configuration)

The schools selected for this pilot provided the local area network (LAN) connection that included the wiring, hubs, network cards, software and installation of the LAN. Advanced Technology Research provided workstations and printers to the schools. The Office of Instructional Services provided the mail software and the Microsoft Works grant provided the integrated software program.

Advanced Technology Research (ATR) of the Office of Information and Telecommunication Services provided support in the following areas:

Coordination and Planning

- Planned and managed the pilot project
- Coordinated the project with school and district personnel

Macintosh LAN Configuration

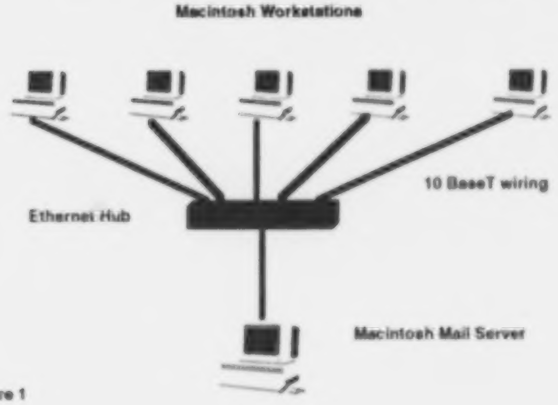
Macintosh Workstations
10 BaseT wiring
Ethernet Hub
Macintosh Mail Server

Figure 1

- Provided consultative services to design and install LANs at pilot school sites
- Assisted schools with the vendor bid process
- Explored educational and administrative applications of E-mail

Installation

- Provided support for installation of Microsoft Mail server and client software
- Connected school servers via modems and the DOE wide area network (See Figure 2)

Training (Staff Development)

- Conducted statewide in service via the Hawaii Interactive Television System (HITS) network
  "Basic E-mail Training"
  "Network Manager Training"
  "Reunion and Update"
  "Celebration and Evaluation"
- Conducted in service sessions
  "Computer Basics"
  "Planning a LAN"
- On-site consultation and training as needed

Modem Connections

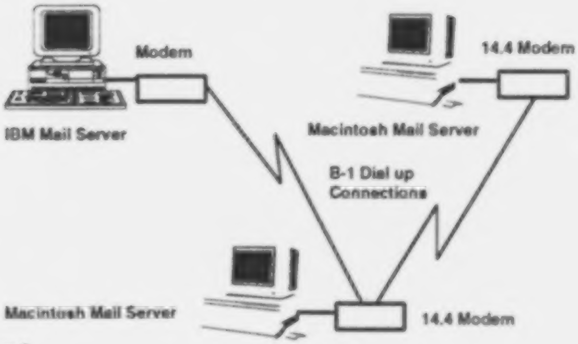
Modem
14.4 Modem
IBM Mail Server
Macintosh Mail Server
B-1 Dial up Connections
Macintosh Mail Server
14.4 Modem

Figure 2

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Operations

- Managed statewide network of LAN's (See figure 3)
- Provided on-going technical support and troubleshooting

Mail Routing: The present routing of mail is through the servers at seven pilot schools. Future plans call for the routing to go through the district server and on to the state server for distribution of the mail traffic. It is estimated that 80% of E-mail traffic will remain within each site and the other 20% will be routed through the district on to other districts and state offices.

State Connections

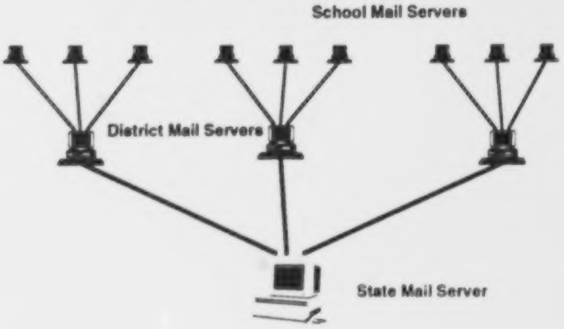

Figure 3

MS Mail Infrastructure:

Each school installed a LAN with a combination of help from various sources: vendors, school staff, parents, volunteers, district and state office staff. The installations ranged from local talk, ethernet to token ring networks (See Figure 4). The network operating systems were Appleshare and System 7.0.1 for the Macintosh networks and LAN Manager and Novell for the DOS sites.

The EMail/LAN Project connected seven school sites with a state office hub. The Advanced Technology A Macintosh server provided connectivity among the six Macintosh servers. (See Figure 5).

Connectivity between the Macintosh and the PC Mail environments required a series of computers. The IBM site is connected to the ATR PC Mail server (Compaq 486) through a Mail Transfer Agent (MTA), function (Wang 386). An IBM Model 25 functions as the gateway from the PC Mail to the Macintosh and completes the connectivity between the two environments. (See Figure 6)

Zoom 2400 modems connected the mail servers at each school site to the ATR office server. SupraFax v.32bis 14.4 modems eventually replaced the Zoom modems for the Macintosh sites (See Figure 6). The DOE WAN is presently replacing the modems for statewide connectivity (See Figure 7). Using the WAN will eliminate the cost of buying high speed modems and the dedicated telephone lines for server connection.

Network Manager Responsibilities: The categories of network managers are site network manager (school or office), district network manager and state network manager. The network managers at each site are primarily responsible for the operation of the local mail server, setting up the new users, training them on use of the mail software, supporting the local mail users and local security. District network managers provide support to users at their district office and to school network managers. Coordination of the routing of mail, district configuration standards and wide area and external connections are the responsibility of the district personnel. The state network manager provides the standards for the connection of all of the mail servers, configurations and compatibility issue resolution, wide area and external connections and system wide trouble shooting procedures. The primary contact to Microsoft, Apple, DOS vendors, and Novell is the responsibility of the state network manager.

EVALUATION AND RECOMMENDATIONS

The evaluation results that were based on usage of the E-mail system, observations, surveys and interviews were positive. The schools designed, installed, and implemented their LANS; they installed the Microsoft Mail server and client software; they sent and received E-mail within their school and to all schools within the pilot project; and utilized the LANS for administrative and instructional applications. Technical difficulties were at a minimum. (The EMail/LAN Evaluation Report is being completed.)

IBM LAN Mail Configuration

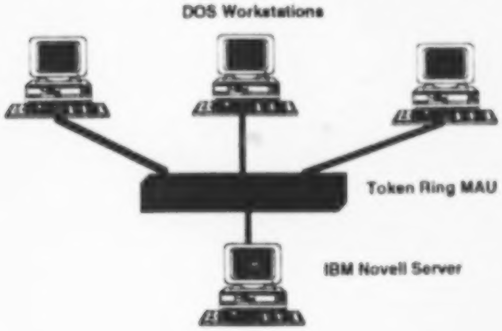
DOS Workstations
Token Ring MAU
IBM Novell Server

Figure 4

On the basis of the first year's results, the project was recommended for a second year with the following adjustments:

- Appoint a state LAN Network Administrator to administer the statewide servers including the Microsoft Mail Macintosh, PC Mail Servers and the connectivity between the LANs statewide
- Explore options for district personnel LAN support
- Expand the number of Microsoft Mail Macintosh Server and PC Mail Server local area networks
- Evaluate Microsoft Mail as the state standard for LAN-based electronic mail during the 1993-94 school year
- Develop plans for migration strategy to reduce the number of EMail systems.
- Develop alternatives for establishing connectivity between MS Mail and other DOE EMail systems and the Internet
- Test the Microsoft Enterprise Messaging Server (EMS) when it becomes available
- Develop ongoing support resources for hardware, software (including MS Mail), network such as phone, bulletin board, training, workshops, etc.
- Explore Microsoft product support options (CompuServ, Product Support, etc.)

Macintosh Server Connections

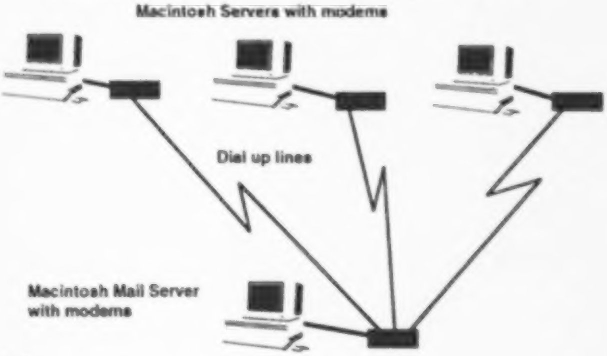
Macintosh Servers with modems
Dial up lines
Macintosh Mail Server with modems

Figure 5

Gateway Connection

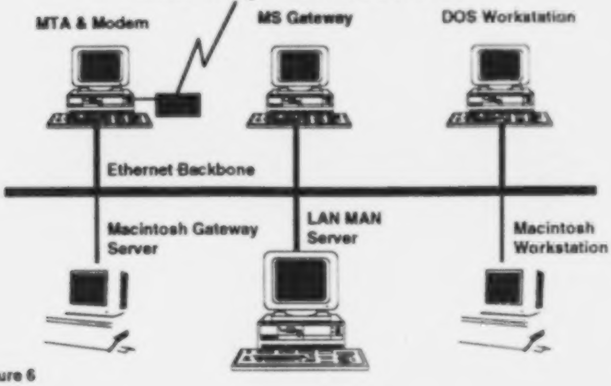
MTA & Modem
MS Gateway
DOS Workstation
Ethernet Backbone
Macintosh Gateway Server
LAN MAN Server
Macintosh Workstation

Figure 6

Doelz Wide Area Connections

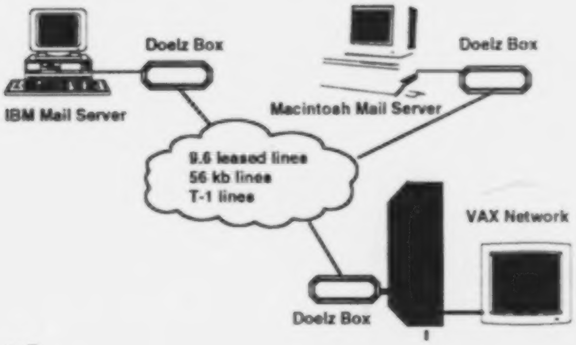
Doelz Box
IBM Mail Server
Doelz Box
Macintosh Mail Server
9.6 leased lines
56 kb lines
T-1 lines
VAX Network
Doelz Box

Figure 7

SUMMARY

In summary, the EMail/LAN Pilot Project, though limited in scale, provided evidence that Microsoft Mail on local area networks is effective for internal and external school communications. Teachers and administrators in the pilot schools liked the user friendly interface, the mail enabled feature, and the file enclosure capabilities of Microsoft Mail. They used E-mail to enhance local and statewide communications that included morning bulletin announcements, memos, project collaboration, binary file attachments, classroom projects such as peer tutoring and debates and electronic newsletters. The future plans are to expand the pilot project to over 30 additional schools and offices over the next year, to test Microsoft Mail on PC networks, to test the gateway connectivity between Microsoft Mail and the four other mail systems in the state and the Internet, and to provide staff and resource support for the E-mail expansion efforts.

CONCLUSION

The EMail/LAN is the first step in implementing the DOE's vision of electronic mail on local area networks in every school connected to the statewide network, wireless networks, Internet, and the National Research and Education Network. Teachers and administrators will be able to send a message, access information, or conduct research anywhere in the world 24-hours a day from any location. This will be the virtual learning environment.

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KAHE KI'I - FLOWING IMAGE

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Honolulu, USA

KAHE KI'I is a study in electronic document management that will enable employees to spend more time providing additional client services. This project was made possible through adjustment of existing operating funds and new monies.

A multi-billion dollar corporation has reports, statistics, data easily stored, routed, and retrievable in a matter of seconds; documents that are filed, indexed and quickly obtained; satisfied employees and customers who find what is requested and needed; - a fantasy? This scenario will save countless employee hours that were spent filing and re-filing, hunting for documents, and manually routing these documents from one desk to another. The time will be better spent providing additional client services. The Hawaii State Department of Education (DOE) is planning to make this fantasy a reality.

KAHE KI'I, Hawaiian for **FLOWING IMAGE**, is a proof of concept electronic document management study that is being undertaken by the DOE in conjunction with a private consulting firm. This study began with a request from the State Superintendent to the Assistant Superintendent of the Office of Information and Telecommunications Services (OITS) to seriously explore electronic document tracking and management. Numerous systems were examined and, considering the needs of the DOE, it was determined that this system must be: compatible with both DOS and MacIntosh environments; be easily modified; and highly user friendly. It was also determined that the workflow should be independent of the image data type. This will allow the organization to monitor work in progress and consequently streamline the operations and meet deadlines in a more timely fashion.

The Office of Instructional Services, Special Instructional Programs and Services (SIPS) Branch was chosen to implement this pilot system. Criterion used to identify the pilot site included: administrative leadership, computers at all work stations, and a willingness on the part of the vast majority of the afffected personnel to reduce/eliminate the paper routing and handling. These were major factors in the selection of this particular branch.

In order to begin this proof of concept study, various steps must be in place beforehand. These are:

- appropriation of funds
- consultation with in-house network services staff
- integrator services
- purchasing/upgrading of work stations
- LAN installation
- system hardware/software
- system modification and customization to meet Branch needs
- user training

APPROPRIATION OF FUNDS

Workload increase monies were requested through the State's budgeting process to fund this year-long proof of concept study. Funding was received July 1, 1993. These monies were combined with branch operating funds. Once this occured, plans could be finalized and services and equipment could be purchased.

CONSULTATION WITH IN-HOUSE NETWORK SERVICES STAFF

The Office of Information and Telecommunications Services (OITS) has a branch within the office whose primary responsibility is Network Support Services. At the onset of this project, several staff members were asked for the Department's cabling specifications. The desired standard for a contained site of approximately fifty users is a six slot concentrator with 24-port 10baseT modules. Level 5 cable was recommended for it is believed this type of cable will allow for expansion so data that will ultimately run over the cable will give the users efficient, almost instanteous access to documents.

INTEGRATOR SERVICES

As part of the proof of concept study, work with a document management integrator began almost immediately. The integrator was made aware of the Department's network requirements and the parameters of this concept study.

Hardware specifications for all user work stations were determined as well as the common software that would run on the network. Both DOS and MacIntosh work stations will be utilized. All DOS machines must be at a minimum 386 level. Both the DOS and Macintosh machines must have minimum of four Meg of RAM to support the software. To date, the integrator has taken a "hands-on" approach in lending support and assistance. He has installed the network software on all equipment, assisted in the determination of the view stations, scanner, and OCR.

PURCHASING/UPGRADING OF WORK STATIONS

Each section provided an inventory of all equipment that would available for this study. All machines were examined based on the specifications established by the integrator. Equipment that did not have sufficient RAM were brought up to the standard and other machines that were not minimally 386 and/or Macintosh were not included for this study. Operating fund expenditures were adjusted to enable the purchase of computers because it is imperative that each section has a full view station. Each section in turn adjusted expenditure plans to purchase its own large screen monitor for the view station, memory upgrades, and network cards for each of their work stations. In some instances, new computers were purchased for the users. The entire system includes: 16 Windows machines and 29 MacIntosh machines. This count includes five view stations, one in each of the sections, and one each for both the director and her secretary. Forty-five staff members of SIPS will be active users of the system.

LAN INSTALLATION

Funding for this phase came from the director's administration funds that had already been budgeted for minimal LAN installation. With limited funding, part of the installation was done by employees within the branch and the project coordinator from OITS. Level 5 cable, PVC piping, and other connectors were purchased. The actual pulling of the cable, done by staff, was completed within two weeks. All cabling runs through the PVC piping and hangs under walkways. Nothing is exposed to the elements. Each of the sixteen rooms has six connections to the server. At this point, two technicans were hired to complete the termination at both the rooms and at the server. This took approximately one week. Connectivity between each room connection and the file server was tested. The system utilizies a managed hub, a six slot concentrator, and four 24-port 10 baseT modules. This expense was borne by the Branch.

SYSTEM HARDWARE AND SOFTWARE

Working with the integrator, it was determined that a Hewlett Packard 9000 file server, Hewlett Packard optical drive, and a Fujitsu scanner, all met the project requirements. The following software is being utilized:

- HP-UX 9.0 (Unix)
- NFS (Network)
- WORD for Windows 2.0;
  WORD for MAC 5.1
- Windows 3.1
- MAC O/S 7.0
- MAC TCP 2.0
- LAN Workplace for DOS 4.1
- Typereader OCR
- Plexus

SYSTEM SOFTWARE MODIFICATION AND CUSTOMIZATION TO MEET BRANCH NEEDS AND USER TRAINING

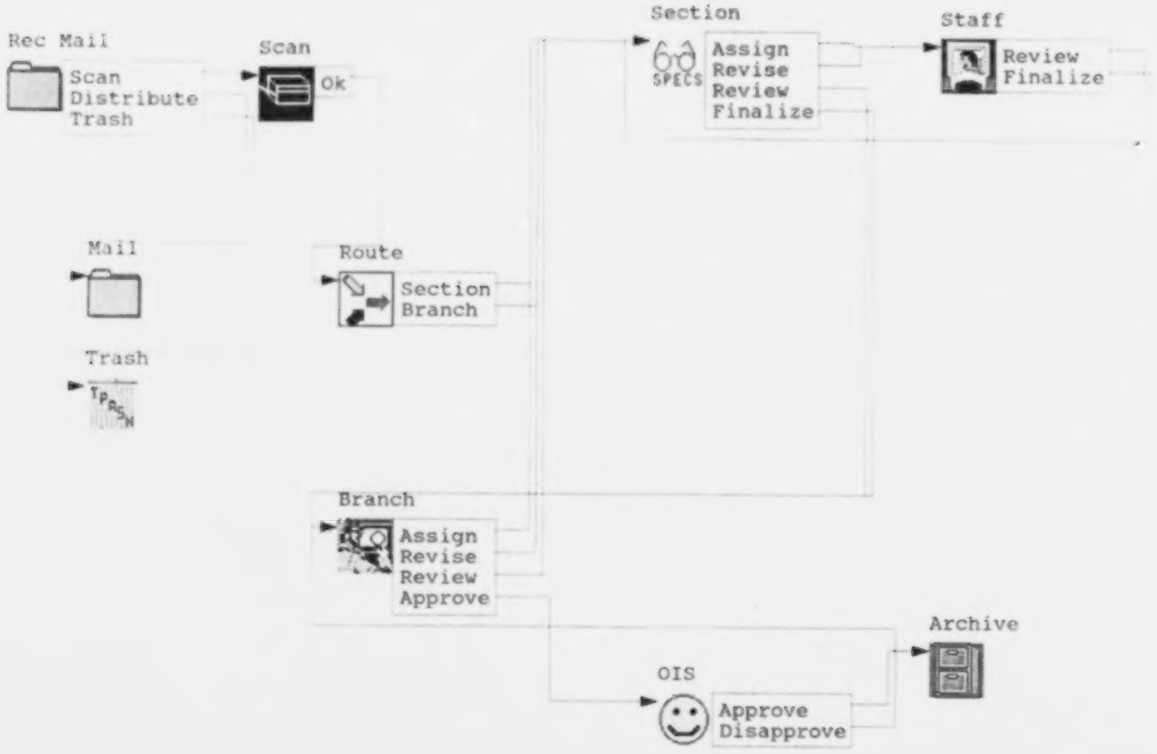
At this juncture, the software is being modified to best fit the specific needs of the Branch. Lengthy discussions are being held with the director to adapt the software accordingly. As the process begins, changes can also be made to meet the needs of the organization and its users.

Once the modification/customization is completed, training for the users will commence. Several levels of training are being planned. One level will be for the director and her clerical staff, one for the section heads and their clerical staffs, and one for all system users.

KAHE KI'I is as its name indicates. This proof of concept study is indeed a flowing process. It is an active, forward moving project that is anticipated to turn the fantasy of easily stored, routed and retrievable documents into reality.

ATTACHMENT: WORK FLOW MAP

WORK FLOW MAP


Rec Mail
Scan
Distribute
Trash
Scan
Ok
Section
SPECS
Assign
Revise
Review
Finalize
Staff
Review
Finalize
Mail
Route
Section
Branch
Trash
TRASH
Branch
Assign
Revise
Review
Approve
Archive
OIS
Approve
Disapprove

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Online Media Catalog and Booking System

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Hawaii State Department of Education
Honolulu, USA

Telecommunication technology offers unlimited potential for providing equal access to information resources for those who live in geographically isolated areas. The implementation of an online catalog and booking service for the Instructional Media Resources collection provides all Hawaii public schools and teachers in the statewide educational system with equity of access, increased order fulfillment efficiency and ubiquitous access to all holdings. This paper briefly describes the background to and recent implementation of this new service.

INTRODUCTION

The Hawaii Department of Education maintains approximately 40,000 items in its centralized library of Instructional Media Resources. Located on Oahu and operated out of the Visual Technology Section of the Office of Information and Telecommunication Services, the library provides 240 public schools statewide with weekly circulation of media resources to support K-12 educational curricula.

The library completed conversion of 16mm film to videotape format in 1990 and the collection presently includes a broad range of videotape titles in both Beta and VHS formats, a rapidly expanding collection of Level 1 and Level 3 laser disks and a wide variety of teacher guides.

Over the years, the complete listing of library holdings were detailed in a printed catalog which consisted of almost 800 pages in 1992. Due to size, only a limited number of copies were distributed to each school. These copies circulated among teachers who then placed their orders through one member of the faculty designated as the "ITV Coordinator." Each month the Coordinator completed handwritten OMR (Optical Mark Reader) order sheets. The sheets were collected at the Media Resources Library, then sent to the central state data processing center. There the OMR sheets were processed and returned to the centralized library for fulfillment. It took an average of 6 to 8 weeks to complete a cycle from initial request to delivery of materials to the school.

ONLINE SERVICE ADVANTAGES

An online catalog and booking system has several advantages over a traditional hard copy catalog and hand booking system. It allows continuous updating of records, thus providing users access to current materials and information. With a shorter turnaround time between booking and actual receipt of materials, teachers can better integrate media into their classroom instruction. From a management standpoint, an online system also allows the library staff to have direct control over record keeping and accountability which was not previously possible when orders were processed by a central state data processing center.

The online catalog and booking service also supports the Department of Education's vision for information technology by ensuring equity and ubiquity of access Teachers in even the most geographically isolated areas of the state have 24-hour access to all materials in the collection including the most recent acquisitions. The several-leveled, time consuming ordering process of the past has been replaced with a few keystrokes on a computer or videotex monitor.

SYSTEM SPECIFICATIONS

After a thorough evaluation of four commercially developed catalog and booking systems, the TD-2000 "D/Max" program from the Tek Data Systems Company in Chicago was selected. This system has an extensive track record with installations in over 500 media libraries nationwide. It provides a multi-user, multi-tasking environment with a large memory capacity, a remote diagnostic capability, customization ability, full-time vendor support and ease of use with teacher-friendly prompts.

The hardware package includes:

- Gateway 2000 personal computer and keyboards (2)
- Tatung Monochrome Display (2)
- SBE Host
- Sony Voice Box
- Realistic Highball-2 Omnidirectional Dynamic Microphone
- GDC Data Com Modem

- DDST II Interface
- Multitech Multi X.25 Pad
- Okidata Microline 393 Plus Printer
- Intermec 9440 Tracker
- Intermec 402 Battery Charger
- Intermec 1545 Barcode Laser Scanner

Four optional custom packages purchased with the system include the Phone Booking System, Bar Code Check-in Procedure, Dubbing Option and the Report Generator. All software utilize the Polyfourth II language for DOS.

IMPLEMENTATION

The Department's online media catalog and ordering service is offered as a closed user service through FYI, the state's information gateway. FYI provides toll-free access for all islands. The closed user status requires each user to enter a specific I.D. number and password to access the service.

The first phase of implementation began in December 1993 and will extend through the summer of 1994. During this time only the 240 individual school ITV Coordinators will have access to the system. This will allow time to fully test the service and customize it as necessary. Full service implementation will begin with the 1994-95 school year when all 10,000 public school teachers can go online.

To prepare teachers for this new service a training package was prepared. Each ITV Coordinator attended a two-and-one-half-hour "hands-on" training session held at each district's Information Technology Center. Each training session accommodated up to 8 ITV Coordinators. This training took place from September through November 1993. A 20-page training manual was distributed and discussed at the training sessions. During this first phase of implementation, each school's ITV Coordinator will help to train his/her faculty members. A training videotape is being prepared to assist the Coordinators with this process.

THE SERVICE IN OPERATION

By dialing into the gateway and accessing the Online Media Catalog, a teacher can browse through detailed information for over 4,600 titles in the collection. After checking its media type, grade level designation and annotation, the teacher is guided, by user-friendly prompts, to order the specific title for the day the item will be used in the classroom. The service automatically books the itemfor a one-week period, ties it to the appropriate shipping date for that district and updates school, district and patron records.

If a teacher does not have access to a computer and modem or a videotex monitor, s/he may still order titles using an optional program called the Phone Booking system. With a touch-tone phone, a teacher is guided through the ordering process by a computer voice on a toll-free line. While this option does not allow access to the catalog, it is an alternative method of ordering materials when the specific order numbers for the materials are known.

CONCLUSION

The powerful medium of video is now at fingertip availability with the D/Max system. Use of the online catalog and booking service empowers teachers to enhance not only their instruction but student learning as well. In the State's vision of educational technology, this application is another step toward universal access to information resources.

School Libraries

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The Department's technological infrastructure is helping transform Hawaii's school libraries into exciting instructional technology centers which support the restructured curriculum. The School Library Networking and other information networks provide all students and teachers equal and timely access to a wealth of local, national, and international resources.

Implementation of the Department of Education's *Strategic Plan for Information Technology* and the resulting technological infrastructure support the Department's instructional initiatives. The Office of Instructional Services (OIS), which is responsible for coordinating these initiatives, has most recently been involved in curriculum restructuring. These restructuring efforts embrace the shifting paradigms in education which include:

- more student-directed learning with the teacher becoming a facilitator to learning instead of a dispenser of knowledge.
- increased recognition of different learning styles and the need to tailor instruction toward these varied learning styles.
- the shift from relying on the textbook as the major source of instruction to the utilization of a variety of resources to deliver and support instruction.

The OIS *Essential Content* document recognizes information literacy and technological literacy as *universal* content, i.e. content that is so essential it transcends all content areas. To be information literate, students must be able to recognize when information is needed and be able to locate, evaluate, and effectively use informational resources. To be technologically literate, students must understand the operations of technological tools and to use them in meaningful, ethical ways.

The school library instructional technology center has always existed to support student learning, and this role is even more critical in supporting a restructured curriculum. It provides the resources (traditional and electronic) to meet individual learning styles/needs. Hawaii's school libraries are evolving into futuristic learning centers. Most of the 240 school library instructional technology centers have automated their collections or are working to complete automation efforts. All utilize the Department's and State's telecommunications infrastructure to access additional resources and services. In addition, they are in the mainstream of school-level efforts to network the school campus with local area networks.

The first of these efforts began in 1980, when the need for computer-based information retrieval (CIR) was identified as one of the four major categories of use of computers in the OIS *Computers in Instruction Plan*. This was followed by several small pilots to study the feasibility of library automation and resource sharing. These pilots evolved into the School Library Network (SLN) which began in 1986 as part of a federally funded ECIA Chapter 2 State Agency management project to begin formal database development activities for Hawaii's school libraries. Today, the School Library Network coordinates all database building and maintenance activities for all 240 public school libraries.

The mission of school library networking is to provide all students and educators equal and timely access to all types of resources at local, national, and international levels to support and satisfy their educational and personal learning needs.

For this to occur for all of Hawaii's public schools, the following must be in established:

- a database at each school library made up of high quality national standard cataloging records, known as MARC [machine readable cataloging] records.
- a local area network (LAN) and a circulation/online public access (OPAC) system operating in each school library.
- a timely, up-to-date state database that is accessible to all students and faculty.
- a resource sharing system incorporating policies and procedures that are cooperatively designed to facilitate interlibrary loan and document delivery.

MARC Records. To ensure high quality national standard cataloging MARC records, the School Library Network uses The Library Corporation's *Bibliofile* software, which contains over 3 million Library of Congress MARC records for database building activities. These records reside on six CD-ROM disks which are accessed by terminals connected to a Novell network. The SLN staff "pull" [download] the MARC records needed by each school library to build its database of unique holdings. At the same time, these records are compressed on the database, which reflects the holdings of all automated school libraries.

School Library Circulation System LAN. Each school library is free to load its unique database onto the Follett Company or the Winnebago Company automation software, two software programs the Department has approved for school library use. The automation software allows each individual school library to circulate materials and its users to search its unique database of holdings particular to that school library.

Statewide School Library Network Database. As the SLN staff builds each school library's database, the school's unique 3-digit code is manually entered into a specific holdings field in the electronic MARC record. All school library titles with their holding codes are then periodically mastered on a CD-ROM disk (referred to as the local disk) that comprises the statewide school library holdings to date. Currently, there are over 145,000 unique titles representing the holdings of 153 school libraries on this local disk. SLN coordinates the mastering with The Library Corporation which does the actual mastering. When this local disk is installed with a commercial OPAC system, the information can be searched by the important MARC record fields: author, title, subject, summary or by keyword.

The state database of all automated school libraries will soon be accessible to public school students, teachers, and librarians via the State's gateway telecommunications network, Hawaii FYI, described earlier. The database, which is searched using The Library Corporation's *Intelligent Catalog* search software, resides on a Novell network. Schools dialing into FYI are then linked to the database through a 56KB line/Timeplex NP100 pad located in the SLN offices. If the FYI user identifies an item that s/he would like to borrow, the school librarian then arranges an interlibrary loan with the library responsible for the material.

As stated earlier, serious statewide school library network database building efforts began in 1986 and continued with ECIA Chapter 2 Funding through 1990. The school library network mission was further enhanced in spring 1990 when the Hawaii State Legislature passed Act 347. The purpose of Act 347 was to expand information and telecommunication services, distance learning technology, and school library network activities. It provided dedicated (distance learning) phone lines for school libraries and computer labs, funds for telephone bills, staff and monies to continue School Library Network Activities, equipment to enhance these efforts at both state and school level, and funds for librarian/teacher inservice. The impact of Act 347 was profound for it now allowed students and teachers in all school libraries to access information beyond the traditional school campus using a videotex terminal, computer with modem, FAX, telephone, lumaphone, or distance learning instructional television program. The free electronic information services they are able to access include:

- Hawaii State agency information
- Hawaii Legislative ACCESS
- Professional support
- Other [library] online public access catalogs (OPACs)
  - Hawaii State Public Library System OPAC
  - University of Hawaii Library CARL System OPAC
- Consortium services
  - Hawaii CALLS
- Communication
  - DLT mail
  - Hawaii CALLS email/Internet

Fee-based commercial bibliographic database services paid for and accessed via individual school accounts include

- Dialog Classmate
- Wilsearch
- Dow Jones

The greatest impact of the infrastructure and services has been that Hawaii's island state location no longer inhibit access to information resources. In addition, student experiences with telecommunications technologies

- enrich their learning environment and activities
- expose them to information resources outside their traditional school setting
- provide them with equal and timely access to information resources
- provide interactive learning experiences

Most recently, the Office of Instructional Services has established the School Library Materials Processing Center (SLMPC) which coordinates the ordering and processing of materials for all 240 school libraries. Materials arrive at the schools fully processed, including barcodes and electronic MARC records, which are then uploaded into the school library's holdings database. In addition, the School Library Network receives a copy of each school library's MARC records that it masters into the statewide school library network CD-ROM database.

State-of-the-art technology CD-ROM and ordering software developed by the SLMPC's mainland book contractor, Baker & Taylor, allows the SLMPC staff to place orders electronically. These orders can also be transmitted electronically to Baker & Taylor. Marcorp Company fund accounting software, which resides on a Sun SPARC system network, allow the SLMPC to do fund accounting for all 240 school libraries. SLMPC staff are currently planning the next phase of the SLMPC operations. These plans include interfacing the Baker & Taylor order software with the Marcorp fund accounting software and utilizing the telecommunications infrastructure in such a way as to allow all the 240 school libraries to order materials online. These orders will automatically interface with the SLMPC fund-accounting and the mainland vendor's 1.4 million title ordering database and eliminate the need for printed, paper order lists.

Our goal is to create the virtual library. To support this effort, we plan to pilot student home to school library dial-up access during 1993-94. The initial access will be to the school library's OPAC with expansion to other electronic information sources. The future of our school library instructional technology centers is exciting. It is filled with change, more networks, more information services, and more exciting opportunities to enhance and support student learning.

COST EFFECTIVE BACKHAUL ROUTES LINKING MAJOR SUBMARINE CABLE ROUTES

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Abstract

The coming of age of unrepeatered submarine cable systems has opened up a new opportunity for restoration traffic and backhaul traffic to be transported via cost effective undersea routes instead of costly landlines. This paper demonstrates a viable solution which is applicable to any system landings within 300 undersea cable kilometres of each other - and therefore is particularly applicable as a future solution within the Pacific Rim as major submarine cable landings proliferate.

1. Introduction - defining the main issue

When key population centres are linked by submarine cables, a "spider's web" of cable systems evolves, as in the Pacific Rim. As the number of major international cable landing points proliferate, the opportunity grows to link these together for restoration.

The advent of 300 km unrepeatered spans using optical amplifiers has seen the maximum system length rise by 50% in the last three years.

Coastal links uniting these systems act as a high reliability alternative to costly backhaul/restoration routes (1).

Although land routes are easier to maintain and require generally cheaper cables, they are also more vulnerable to third party damage. Submarine cables, and unrepeatered cables in particular, are more secure but less easy to repair; making land and submarine systems complementary. The unrepeatered system can be viewed as a 'trunk highway' while the land route acts as a series of 'suburban links'.

The main issue is defining the criteria which are required to link selected neighbourhoods in the global village.

2. Land or sea? - how do the lifetime costs compare?

With the latest optically amplified technology, a 1.2 Gbit/s capacity submarine armoured cable system including terminals can be manufactured, project managed, and installed for less than US$10 per metre for a 300 km system.

The analysis of system cost to the system owner for an undersea restoration/backhaul link starts with route engineering. This can broadly be defined as all the work necessary to ensure that the cable product chosen for the route matches the undersea constraints, together with establishing the viability of installation and maintenance along the route. The results are matched against the requirements of the system owner, and the level of cable protection can be established.

Factors considered at this stage include whether the cable should be buried or laid on the surface of the sea bed. This decision is a complex one, dependent upon the nature of the sea bed and external factors such as fishing activity. For an unrepeatered system which is part of a network, the level of protection required for a given route may be lower compared with a major international link. Network diversity has an impact on the level of armour protection needed for a given cable route, and explains why a new generation of lower cost, smaller cables will become more popular over the next decade.

The same principle applies to the protection of shore ends. Utilising the services of a shore end specialist to install these cable types in shallow water, ensures that the maximum system security can be achieved.

The method of transporting the cable from the factory to the system location, together with the laying method, are both factors to be considered at an early stage in the project. These, together with details of pre-existing terminal stations and flexibility in the date of installation, help to optimise the cost of an undersea link.

Landline systems can cost between US$15 per metre and US$45 per metre to bring from conception to start of operation. The ease of introducing land based repeaters means that the link between capacity and system cost has less influence than the submarine case. The reduced need for optical amplifiers assists landline systems strongly in this regard.

Landline optical system costs are also influenced by the type of installation needed (directly buried, ducted or aerial cable). The location of the system will also significantly affect the cost, with systems in towns or cities costing more than twice those in rural areas. For buried cables, the cost will be affected by the route (next to railway lines, under a grass verge, or most expensively a trench in the road). Considerable environmental impact can be caused by such activity, and this plays a major part in the decision making process. The viability of landline systems is also affected by the cost of both the cable and the civil construction.

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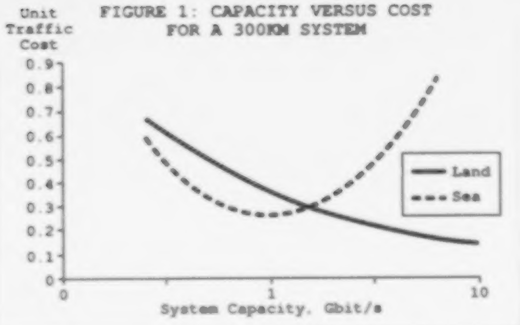
FIGURE 1: CAPACITY VERSUS COST FOR A 300KM SYSTEM

As seen in Figure 1, submarine systems offer a competitive solution for total system capacities below 1.2 Gbit/s. Above this capacity the cost of terminal electronics (including optical amplifiers) makes equipping a system with high fibre counts impractical. In future the crossover point on this graph will undoubtedly be pushed to the right, towards higher system capacities, as pump laser reliability and laser powers improve. At lower capacities, land installation and repeater costs serve to push up the unit traffic cost compared with the equipment efficient undersea alternative.

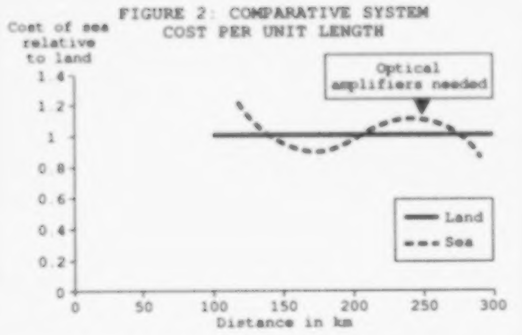
FIGURE 2: COMPARATIVE SYSTEM COST PER UNIT LENGTH

Figure 2 shows the relative system cost per unit length as the length increases. At lower lengths, landline systems have the advantage, but for a small window the submarine systems become competitive. This occurs as the low cost per unit length of upgrading terminal equipment, using better lasers and receivers without resorting to optical amplifiers, yields improved cost efficiency for submarine systems. However, when optical amplifiers are needed, the cost benefit is reduced until the cost can be spread over a longer length. As the system length nears 300 km, a crossover point can occur where the submarine system is once again more cost effective. The exact position of the crossover points is determined by the nature of potentially competing land and sea routes.

Submarine cable systems have conventionally been viewed as expensive when compared with landline solutions. The above analysis indicates that with the dawn of optically amplified technology there is a break even point where submarine systems are more cost competitive.

In particular, where the submarine route is shorter than the equivalent land route, or where cities cannot be avoided, the justification for submarine backhaul/restoration becomes compelling.

Another key factor in the debate is the cost of operating and maintaining the land and sea systems. This is difficult to determine because neither landline nor submarine systems would be expected to operate as stand alone systems. Both would form part of wider networks.

At 1994 prices, the unrepeatered submarine system is expected to cost less than US$1.30 per metre per year to maintain, if entered into an existing maintenance arrangement. The land maintenance charge is dependent upon the additional people required to operate the system and could be expected to cost less than $0.50 per metre per year.

These figures would be offset by repair costs, which for a submarine system would be less often but more expensive per repair (see Figures 3 & 4).

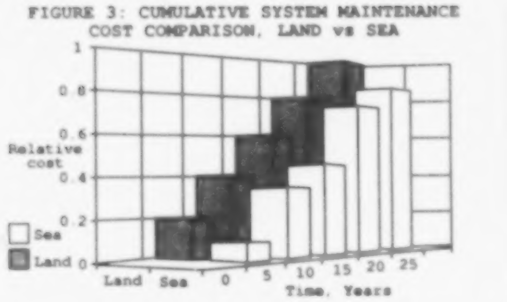
FIGURE 3: CUMULATIVE SYSTEM MAINTENANCE COST COMPARISON, LAND vs SEA

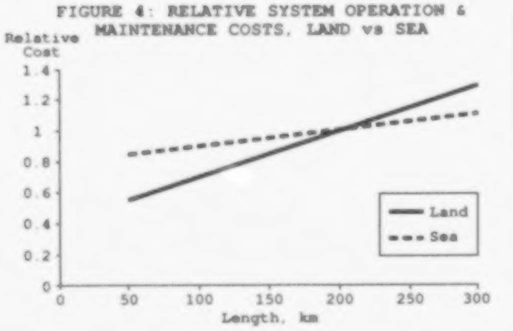
FIGURE 4: RELATIVE SYSTEM OPERATION & MAINTENANCE COSTS, LAND vs SEA

At this point it becomes clear that the two systems are complementary. The submarine system is more reliable but expensive to repair. The land system is less reliable but cheaper to repair. Herein lies a strategy for network strength. Instead of relying on one or other

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technology, it becomes possible to design a very robust network which is operated over a mix of technologies. For the service provider who chooses to employ backed-up routes, a valuable opportunity to optimise the network is given by a mix of land and submarine routes. In this context, 'The missing link' of the ITU report of December 1984 (2) could be described as the unrepeatered submarine link which secures the national and international network. Cable and Wireless has already used this approach to good effect in its Global Digital Highway.

3. **Cable design trends** - designing for the application and the need for effective route engineering

Unrepeatered submarine systems clearly have a significant place in backhaul and restoration planning.

For long haul submarine systems it is possible to justify employing technology which exceeds the requirements of the route. The risks involved in losing traffic from such a system carry with them potentially massive penalties, including loss of earnings, restoration costs and, ultimately, loss of market acceptance.

However, a backed-up backhaul/restoration route carries a much reduced level of risk. This means the submarine cable can deliberately be designed to accept a higher level of risk over its lifetime if it accompanies a landline route. Together, they meet the overall reliability objective.

For submarine cable systems, economies have been achieved by reducing the diameter of the cable, which is the major cost component of the system. This has immediately had a knock-on effect to the marine installation, allowing smaller, simpler vessels to be used. An additional benefit is that both manufacturing periods and overall project durations have reduced, leading to less expensive project management.

The value saved by changing from conventional submarine cable to the new generation of unrepeatered cable alone might pay for a landline system and (in aggregate) increase the overall reliability of the link between two places. While to every rule there is an exception, the general principle still stands that two less costly links (land and sea) are more effective than one.

The cable design process must be flexible enough to cope with rapid changes in demand caused by route engineering analysis. Cable and Wireless Marine's experience in this matter recently proved invaluable when collaboration with a manufacturer enabled a design to be upgraded, tested, sea trialled and deployed within a four month period. This enabled an urgent requirement to be met, and an unrepeatered submarine backhaul was in place only six months after receipt of the survey information.

4. **Cost effective installation** - economy without loss of integrity

The absence of submerged electro-optics and the previously discussed reduced diameter of the submarine cable, affect the system cost breakdown, and result in the cost of the marine installation comprising a larger proportion of the total. For systems of this type it can range between 30-60% of the total purchase price. Any economies that can be made without endangering the product reliability will increase the viability of the marine solution.

Over the past 15 years purpose built cable ships have developed in technical complexity to such an extent that they are the most sophisticated commercial ships afloat. There are many valid reasons for this, but the result is a ship that is expensive to operate and often inappropriate for the installation of unrepeatered systems.

The method of installation can be re-evaluated to determine the most cost effective solution: it is not tied to a traditional cable ship method.

Route and operational factors will determine the size, complexity and cost of the vessel(s) needed to install the system. If the cable can be laid in a single length, the cost of a separate shore end vessel can be avoided. If the cable is laid on the surface of the seabed, the installation will be much more cost effective than deploying a vessel with a plough.

For a typical unrepeatered system the installer will mobilise a vessel of opportunity with the necessary equipment to meet the customers' requirements. The limits set on factors such as navigational accuracy, position keeping, slack control, and burial performance will directly affect the mobilisation, demobilisation and operating costs of the vessel. It is important to differentiate between what is necessary and what is traditionally requested. If a ship of opportunity is required then it is not necessary to specify a cable ship.

Significant cost savings over a traditional cable ship solution, can be made by careful route engineering, realistic specification and flexible implementation methods. Achieving the optimum cost base depends on involving marine installation expertise from initial desk study, through survey, cable type selection and mobilisation, to installation.

In considering a reduced specification installation, it is important to remember that cost is saved by reducing the sophistication of the lay spread. In so doing increased reliance is placed on the experience and expertise of the installer.

The next cost decision is where the installation vessel should be mobilised. This is a matter for the cable manufacturer and the installer to resolve. The vessel can collect the cable from the manufacturer's factory. However, ships mobilised for cable laying tend to be more expensive than freighters. The installer could

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instead collect the cable with a converted freighter and then transfer the cable to the installation vessel mobilised close to laying area.

Alternatively, small diameter cables can be transported in ISO containers and so could be shipped by commercial cargo routes to the laying area, assembled into the system length and then loaded on to a locally mobilised installation vessel. Each project is unique and the optimum solution is a complex mix of manufacturer and installer costs, affected by such things as total system length, manufacturing schedules, relative locations of factory and laying area, and project time scales.

Mobilising the right vessel with the correct cable handling equipment and managing the operation to ensure safe and successful system installation requires an intimate knowledge of the route, good understanding of the handling limitations of the cable, and most of all, knowing the limitations of the vessel and the lay spread.

These skills are only developed by experience.

5. **Maintenance** - cost effective strategies

To verify that submarine systems can compete with landline systems as backhaul/restoration routes, an analysis of the comparative costs of operation and maintenance should take place. The validity of assumptions made for maintenance of submarine systems needs to be confirmed. In the experience of Cable and Wireless, it is not absolutely necessary to enter the submarine backhaul route (particularly if it forms part of a network) at the full repeatered level of maintenance service.

This may mean lowering the call-out priority in the event of a maintenance requirement. At least two Cable and Wireless unrepeatered systems have successfully been entered into existing maintenance arrangements on this basis. The repeatered system owners are pleased to 'top up' maintenance cost contributions without significant adverse effect on their existing arrangements.

Where this strategy is not possible, an alternative is to devise a 'call-out service' for the unrepeatered system. In the experience of Cable and Wireless Marine such an arrangement does not become viable unless there are at least 1000 km of submarine cable together in one 'club' arrangement. It is not advisable to rely on the manufacturer for such a service, as he is geared more towards keeping his product range up to date rather than supporting installed systems.

Significant cost benefits can be gained by employing specialist maintenance providers, such as Cable and Wireless Marine, who can provide economies through pooling of resources (including universal jointing technologies), especially people with skills across a wide range of systems.

As an alternative to a 'breakdown maintenance' philosophy (which is rarely adopted by telecommunications customers), it is possible to design maintenance equipment to be stored in 20ft containers, which can be rapidly deployed and unpacked onto a ship of opportunity in order to carry out urgent repair work. The viability of this solution will depend on the availability of suitable vessels and the length of call-out time which would be acceptable to the system owner.

6. **Previous Applications** - Case Study 1: Backhaul Link - 100 km 2.5 Gbit/s System

At the beginning of 1993, the survey information for a 100 km link (joining the PTAT Cable to the TAT-11 cable) was issued to the supply consortium, by Cable and Wireless Marine. Although a substantial amount of desk study work had already been carried out, the survey report showed that a significant portion of the route was subject to both strong tidal currents and poor sea bed conditions.

Where in a conventional system a decision would have been made to opt for a very costly rock armour cable design, the design philosophy which had been agreed upon, together with budgetary constraints, meant that such an option would have been inappropriate. Instead, by agreement between the supply consortium and the customer, a rock armour variant of the chosen small diameter cable was designed, prototyped, tested, trialled and installed over a 16 km portion of the route. This is all the more remarkable because this progress was achieved within the original agreed time frame for the project. Five months after the survey report was issued, the submarine link was installed.

At the time of installation, the investment in cable route engineering had an opportunity to recoup itself. In particular it was crucial to choose the vessel to match the application. By careful planning it was possible to use a converted coaster kept in position by two tugs, in some of the world's strongest tidal conditions.

Performing the operation successfully depended upon involving the installer from the desk study phase, through survey, choice of cable types, mobilising the appropriate cable handling equipment, vessel management and trialling the facilities before deploying the first kilometre of cable.

Such a strategy enabled an installation to be carried out at half the cost of a traditional cable ship.

The installation cost could have been halved again if economies had been made in survey, route engineering, tug deployment and other key aspects of the cable installation, but these were correctly judged to be false economies. Other companies have found this out to their cost. Examples of problems they experienced included the inability to bury cable due to inadequate survey, and the uncontrolled coiling of armoured cable which had not been designed and trialled fully.

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In essence, with simpler laying technology, the installer is more heavily dependent upon managing the operation with people who have a good knowledge of submarine cables, a good understanding of the route, and a clear idea of the limitations of the laying spread.

For this particular project, a further complication was caused by the need to bury the cable in a 1.5 km inter-tidal zone. In order to bury the cable into the mud, a specialist burial device was towed by winching it from the shore. Planning, preparation and trialling ensured the success of this part of the operation.

The terminal equipment was installed and commissioned within a further month of installation, giving a total project duration of six months from award of contract through to end of commissioning. Within a further month all the system stability trials were complete and the system was ready to carry traffic.

This was achieved in the same amount of time it took to complete a shorter, more expensive land route which linked one of the terminals to the national network. Thus, route diversity was possible from the day the systems were switched on. Both international and national route diversity are now available, connecting PTAT to TAT-11 and supplying a diverse route between the two to the National Network in the UK.

The system uses Synchronous Digital Hierarchy (SDH) equipment, which makes it the first of its kind in the world. At PTC'93 it was predicted that further studies would be needed before such systems could proceed (3). Cable and Wireless Marine is pleased to report that, at the time, a system of that type was already well beyond the planning stage, and has now been successfully in service for five months, paving the way for SDH unrepeatered technology in the Pacific.

7. **Future applications in the Pacific Rim** - case studies

In the Pacific Rim, the next ten years of unrepeatered systems promises to be a time of enormous growth for the technology as the distances increase between landing points.

Developing nations face some of the most exciting possibilities over this period. Countries such as Vietnam, which are being linked into the global network through systems such as TVH (Thailand-Vietnam-Hong Kong), now have an opportunity to expand their domestic network through coastal festoon systems. The changing nature of the technology means that developing countries will be telecommunication systems operators of the most advanced technology on earth.

In Korea, an opportunity exists to connect RJK (Russia-Japan-Korea) and HJK (Hong Kong-Japan-Korea) to establish a self healing regional network. Only recently has that particular potential link become possible through unrepeatered technology. This advance significantly reduces the potential capital investment when compared with a repeatered link, which would not be viable.

Opportunities to apply the principles in this paper are even possible along the west coast of the United States, where connectivity between existing systems through festoon links could become much more economic than implementing new international repeatered systems.

As optically amplified repeatered systems become the norm over the next decade, the opportunities will grow to add regional networks feeding high capacity optical 'pipes' for trunk traffic. The future implementation of the FLAG network is a prime example of this possibility.

Unrepeatered optical cable systems are viable as submarine backhaul and restoration routes. They can be expanded into coastal festoon systems to act as regional networks feeding high capacity systems. The technology now exists to span 300 undersea cable kilometres without submerged electronics, using optical amplifiers controlled from the terminals.

Cable and Wireless Marine has kept the cost of such systems competitive by using small diameter cables, high quality route engineering and simplified installation managed by experienced people. System maintenance costs have been minimised by tailoring the level of service required to the specific application.

Many opportunities now exist in the Pacific to capitalise on SDH unrepeatered systems, and these will grow as the millennium approaches.

8. **Acknowledgements**

The author gratefully acknowledges the valuable assistance of Stewart C. Ash in the preparation of the marine installation section of this paper, and Mark Aldridge in the assessment of future case studies.

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Submarine Fiberoptic Systems: A Building Block for Developing Nations

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1.0 ABSTRACT

Global integration is creating a climate of change that will endure well into the next century. Those who can recognize the signs of change and adapt to accommodate change will garner the opportunities to come. This paper discusses the signs of change and how nations, both developing and industrialized, must develop strategic communications plans designed to attract multinational corporations and foreign investment in an effort to lead their countries and regions to prosperity.

2.0 INTRODUCTION

Success in any market is chiefly determined by providing the right product to the right customer at the right time. Although there are many factors that affect this scenario perhaps the most critical factor is the communications capability of a nation. Clearly the ability to communicate has been identified as one of the critical elements leading a nation to prosperity. Supporting the notion that a good telecommunications infrastructure is not only important but a large influence on the prosperity of a nation, we need only to look back a decade ago, when the International Telecommunications Union established an independent commission chaired by Sir Donald Maitland of the United Kingdom to study telecommunications as a factor of economic development among the nations of the world.

The findings of the Maitland Commission were published in 1984 in the report entitled *The Missing Link*. At the time the commission reported that a significant majority of telephones were concentrated in only nine nations. It also determined that telephone service was more than a luxury. Rather, it had become an essential factor in economic development. Based on the findings of this commission and several subsequent studies commissioned by the World Bank and other agencies, many nations and regional alliances have begun development efforts to correct the imbalance among the connected and disconnected nations of the world. At the same time, advances in technology and the uses of information have increased the importance of worldwide connectivity for all nations.

Today, many developing nations have found their link to the global marketplace through telecommunications. Others have started factoring information technology into their strategic plans for growth. Despite a global economic recession, we find a handful of developing nations in the Asia-Pacific experiencing consistent economic growth hovering above 6 percent annually. These include China, Hong Kong, Indonesia, South Korea, Malaysia, Singapore, and Thailand. Another group of countries in Latin American have also begun to show signs of real economic strength with an average growth rate of about 4.5 percent. These nations are Argentina, Colombia, Chile, Mexico, and Venezuela. The development of an effective telecommunications infrastructure connected to the global network is one common characteristic consistently found in all these growing countries. Although no one claims that connectivity alone is the secret to economic growth, one can clearly see that in today's fast-paced global market lack of connectivity can impose significant barriers to growth.

3.0 COMPETITION FOR ECONOMIC DEVELOPMENT

Competition takes place in the arena of economic development to attract companies and even entire industries. Around the world, nations promote their resources and offer incentives for companies to locate production capabilities and service centers within their boundaries. This competition often centers on trying to convince business enterprises that the competing nation offers the right combination for success, including access to four key drivers, technology, markets, transport, and finance. Although telecommunications can provide access to these drivers, undersea fiberoptic cable facilities can deliver access to them on a global scale. And, global access is the key advantage that fiberoptic connectivity offers any nation regardless of its position along the spectrum of economic development. Developing nations that want to compete need to be connected, and access to the global network provides a positive road to prosperity.

Telecommunications in the information age is what transportation was to the industrial age. Where once highways and bridges were essential to economic development, to compete for business and external investment today, a nation needs a communications infrastructure capable of creating an environment for opportunity.

A successful national economic development strategy looks at infrastructure as part of a dynamic investment cycle in which a primary investment in a key sector tends to attract subsequent investments in other sectors. The key to making this investment cycle produce is to identify the sector(s) that offer the greatest promise for direct foreign investment. And, telecommunications has proven to be a specific key sector that deserves priority attention in the development of a nation's investment cycle. Studies subsequent to the Maitland Commission's report indicate that investments in telecommunications consistently produce immediate and substantial returns.

Access to the global network attracts information-age jobs without requiring large-scale investments in buildings or facilities. Desktop workstations can access remote computer hosts over the global network to perform a wide range of work functions, from computer programming to data entry. As a result, telemarketing, hotel and airlines reservations systems, and help desks can be located anywhere in the world. Some of these applications have already been developed in locations such as Jamaica, Ireland, and India to serve the growing needs of information-age corporations in Europe, Japan, and the United States. Such opportunities are the direct result of adequate connectivity between the distant location and the host nation.

Prior to the Maitland Commission report, the Missing Link, telephone service was once considered a luxury for personal convenience. However this report indicates that more than 80 percent of the telephones in developing nations are connected to business or government agencies. It also specifically illustrates how investments in connectivity produce dramatic changes in an area's economic productivity. These studies are further confirmed by the experiences of other agencies engaged in the financial support of such telecommunications projects. For example, the World Bank has been tracking results for telecommunications infrastructure projects that it finances. It has estimated that economic returns of its telecommunications projects average better than 20 percent even under conservative estimates. Those estimates are based on projected user revenues for services and do not reflect such collateral benefits as increased productivity, improved marketing capabilities, or enhanced appeal for outside investment.

The experiences of improving communications infrastructures for these developing nations suggest that such investments mean more than just one more component in the development process. Rather, they show that communications is an essential link required to improve productivity and efficiency of developing nations. Readily available information and analyses consistently depict information technology as the single-most important investment required for enhancing the quality of life in developing regions. It enhances development activities in such sectors as agriculture, education, healthcare, manufacturing, shipping, and social services.

Specifically, a well designed telecommunications network that provides access to the global network will greatly improve efficiency and productivity in these areas:

- Market price information: businesses can obtain and compare market prices enabling them to seek the highest prices while reducing their dependency on middlemen in intermediate markets.
- Market planning: manufacturers can modify the types of products manufactured to respond to demand when they have access to market information in a timely fashion.
- Reduction of downtime and inventory: access to information about available inventories will allow businesses to develop an adequate inventory of maintenance items and spare parts without tying up precious capital in redundant stores.
- Timely delivery: contact between manufacturers and shippers to arrange scheduling for delivery of products to market can result in more efficient scheduling of transport systems.
- Decentralization: telecommunications can distribute economic activity away from urban areas to avoid some of the problems and costs associated with concentrated populations while also preserving indigenous cultures.

4.0 THE ECONOMIC WORLD OF INFORMATION

In the arena of global business and technology, then, it would appear that the most critical asset a nation can offer is access to the global network through fiberoptic connectivity. The correlation between global connectivity and national prosperity is direct and demonstrable. The twenty or so nations connected today by fiberoptic cables are among the world's most economically advanced. They have a combined gross domestic product that amounts to about 52 percent of the world's prosperity, yet their populations comprise only 17.9 percent of the world. It is anticipated that within the next several years, the nations that will enjoy fiberoptic connectivity to the global network will double. And, even nations that are landlocked now will have greater potential to access the global network via terrestrial fiberoptic cables. Thus, fiberoptic systems, both submarine and terrestrial, provide the foundation for a global network over which much of the world's business is taking place.

5.0 UNDERSTANDING THE FORCES OF CHANGE

Driven by fundamental shifts in the way people communicate, the global marketplace is changing faster than anyone can record it. Today, for the first time in history, a handful of developing nations are participating in those changes. Some of them have already begun to benefit by taking full advantage of the forces of change. Many long-standing barriers to trade are beginning to fall, and many governments also have become new agents of change. The changing role of government, the emergence of global business, and rapid developments in information technology are new forces in the marketplace coming together to create change as irreversible as continental drift.

One sign of change is the emergence of a new world order. The disintegration of the Soviet Empire is old news today. The end of the cold war has forced a new assessment of the positions held by individual nations and ethnic groups in the global political landscape. These changes are best exemplified in the recent accords that have been and are continuing to be conducted in the Middle-East. These accords indicate that the necessity for and opportunity of participating in global commerce and sharing in its rewards is no less a motivating factor than is the desire to end national strife.

The road map to a global economy traverses an intervening step through regional trading blocks. As one of the world's oldest and most advanced regional partnerships, the European Community (EC) offers one model for the successful integration of national economies into larger structures. Yet the EC is one of more than a dozen regional trading alliances around the world. In North America, South America, Africa, Asia, and along the Pacific Rim, we find many nations coming together in new coalitions focused primarily on trade.

The motivations for regionalism are many, but they are of particular importance to developing nations. As these nations ready themselves for global competition, some fear they will not be able to compete effectively. Others want to ensure they have ample resources available before they compete openly. These trading alliances provide those nations the opportunity to get their national programs in order by forming strategic regional alliances that will enable one nation to leverage the strengths of its neighbors, thereby softening the impact of global competition.

As the nations continue to negotiate their places within regional agreements, Multinational Corporations (MNCs) also aggressively seek local representation within the various regions. Their motivation recognizes that mutual trade among regional partners expands significantly as those new alliances grow in importance. Local representation within a regional group helps to assure a share of the emerging market. Now that the fortunes of so many nations and corporations have become so intimately and mutually entwined, developing nations are progressing toward economic integration with the rest of the world at a faster pace than ever before.

Complementing the trends that eliminate national protectionist barriers are universal trends toward privatization and liberalization of national telecommunications networks. These trends are changing the services available to users as well as the shape and face of how systems suppliers and service providers deal with new and growing markets. Governments are now starting to recognize the profitability and financial potential of their telecommunications resources when they are properly structured and effectively operated. The scarcity of financial resources among developing nations have governments seeking creative new financing solutions. Solutions such as Build, Operate, and Transfer (BOT) programs designed to gain needed assistance with financial resources are beginning to appeal to some governments. Others seek supplier or third-party financing options. And still others openly invite foreign investment as the nations look to technology transfer, education programs, strategic alliances, and joint ventures as opportunities to address the challenge of inadequate resources. Nations recognize that becoming competitive requires adopting new and innovative programs, both in the public and private sectors.

6.0 PRODUCTS DEVELOPED TO CUSTOMER NEEDS

In the world of undersea fiberoptic cable systems, developing new products to meet the needs of customers is extremely challenging. Today, in the submarine cable system market, there is a new mix of customers consisting of international carriers, regional and national carriers, plus various end users such as MNCs and other international and national businesses. The challenge of the global marketplace is further heightened by the fact that many of these roles are dynamic and changing, depending upon specific needs.

In evaluating these needs it is of paramount importance that products on the drawing boards today be designed in accordance with the changing needs of the global marketplace. Needs that will demand undersea fiberoptic cable systems have characteristics such as:

- Upgradeable and flexible functionality allowing for greater capacity or more interconnections as needed.
- Respect for national sovereignty including the need of a nation to control its own traffic locally while also connecting with the global network.
- Independent connections so that the failure of one nation's or one user's capability does not affect another nation.
- Restoration through automatic rerouting of traffic where possible.

However, as complex as this new environment appears to be the real challenge is to continue and move ahead to tomorrow, move ahead in understanding what the requirements of the global marketplace will be in the 21st century.

From a undersea perspective there are two key areas of technological development in fiberoptics that will likely have the greatest impact on telecommunications capabilities moving forward into the next century. They are transmission and network interconnection.

Tomorrow's transmission technology will provide all photonic transmissions with no electronic regenerators to limit flexibility. The resultant design will be inherently more reliable because of the simplicity. The potential for growth of future systems and the synergy of future systems with first generation systems is a very attractive element of optical amplifier transmission technology because optical amplifier systems offer the possibility of upgrading the capacity of an existing system by making changes to the equipment at the shore.

The second key technology, Network Interconnection technology will also become more cost effective and more flexible. This flexibility will come from designs that build on emerging standards such as Asynchronous Transfer Mode (ATM) and the SDH/SONET synchronous standards. Inherent in these synchronous standards are the network management capabilities enabling effective control from a single operations center located anywhere along the network.

Network interconnection technology will offer even more protection in response to demands for integrity, security, and reliability expressed by systems operators, individual nations and multinational corporations. Depending upon how one looks at the mix of customers and their requirements, demands such as global connectivity and national sovereignty might even appear to be contradictory. But networking technology today has evolved from the simple point-to-point configurations of a previous generation to a plethora of topologies including branching, multiplexing, and network ring configurations. These flexible topologies combined with international interconnection standards enable suppliers and system operators to respond to these demands with cost-effective solutions.

The application of technology developed to address customer needs is a reflection of how end users are driving change. End users of undersea cable systems are primarily businesses with a fundamental need to remain competitive in today's global environment. They demand access to advanced technology for their own operations, and they are coming to rely upon the advanced technology of the global networks to provide ubiquitous access in all of their locations. Those demands include everything from dial tone to greater capabilities and services. Such as, Video Conferencing to facilitate meetings where visual effects are important, Computer Aided Design to support manufacturing activities, Medical Imaging for remote diagnosis, and Interactive Data Dialogue to facilitate direct marketing functions. They also require increased information security to prevent unwanted intrusions to their information resources. And, they need higher quality services and capabilities responsive to specific needs on demand. And they insist on greater reliability.

7.0 A SHIFT IN ADVANTAGE

The paradigm shift that has changed the nature of information and the global marketplace has exerted a profound and beneficial effect on the future of developing nations. Key to the shifting advantage for developing nations is global connectivity via undersea fiberoptic cable systems. Where once the marketplace exerted a few demands which were easily understood by all the players, today those demands vary according to geography, market size, and available technologies. As end-users take advantage of global connectivity, available bandwidth, and advanced technologies to make themselves more competitive, developing nations can also use the same tools to compete in this complex marketplace.

The role submarine fiberoptic equipment suppliers play in this complex equation entails responding to marketplace forces by making their products more affordable, easily deployable, and more responsive to the changing global market. The challenge of getting responsive products to market relates directly to the growing user demands and the responsive technological solutions offered. The global market is changing dramatically and new customers who are entering the marketplace look to equipment suppliers to satisfy needs not presently met elsewhere.

These challenges are exciting, because they require building the global infrastructure that will eventually drive the networks of the future. With connectivity, bandwidth, and available services, everyone, including developing nations, will be better equipped to compete more equitably in the global marketplace. And, in this new competitive environment submarine fiberoptic systems clearly provide developing nations new opportunities to sharpen their competitive edge.

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COST EFFECTIVE INSTALLATION AND MAINTENANCE OF SUBSEA LINKS FOR DEVELOPING ECONOMIES.

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ABSTRACT

Exploration of concepts for modular, transportable and ingenious cable installation and repair. These aspects are discussed with reference to customer needs and local environments and, in particular, opportunities to be gained by technology transfer, and the advantages that may be gained from interaction with the region in which the cable is to be installed or maintained.

1.0 INTRODUCTION

From the laying of the first submarine telegraph cable to the present day, cable installation and maintenance companies have managed to keep pace with the technology requirements of manufacturers and customers.

This has been achieved to date by using fairly conventional installation techniques for cable types that have not changed a great deal in size or weight. One of the main considerations for installation of the long haul analogue cable system was the ability of the lay vessel to store the repeaters. This need, and the ability to handle relatively large cables in deep water, tended to dictate the shape of some of the cable ships in existence today.

In the early 1980's with the advent of optic fibre technology there was an expectation that the cable size would reduce dramatically, leading to a substantial cost saving.

In some cases however, and probably due to the concern about the fibre endurability, cables actually increased in size.

Cable packaging, engineering and removal of power feed requirement for repeaterless systems, has enabled many manufacturers to concentrate on reducing cable size. Coupled with the advances made in cable protection through seabed burial, the outside diameter of repeaterless cable has generally decreased to around 18mm.

Repeaterless technology is now moving the distance barrier further and further, cables are being made smaller and a totally new concept of installation and maintenance has to be considered.

This paper discusses the exciting new developments and challenges that companies like BT(Marine) with its Integrated Subsea Installation Service (ISIS) are currently engaged in.

2.0 WHAT IS THE TASK AHEAD?

As one of the first companies to install a commercial conventional submarine optic fibre cable, we believe that it is very important to continually upgrade and develop plant that meets clients needs.

For many of the existing players in the installation and maintenance market, the investment needed to serve the traditional market has been high. There is therefore an obvious reaction to try and utilise existing assets where ever possible to serve new market trends and demands.

This may, until now, have actually slowed the advancement of repeaterless systems through inefficient proposals. Repeaterless systems will, after all, still have to compete with terrestrial systems such as microwave and satellite which can, in many cases, boast a good track record.

There are no reasons why a correctly installed submarine cable can not give years of fault free service that not only competes with other transmission mediums but also complements them to suit environmental criterion.

An example of this versatility is a repeaterless submarine cable system installed by BT (Marine) in 1989,which was required to link with other transmission mediums on an international basis. It was 140km in length from shore out to an offshore UK North Sea platform which then radiated out to five other platforms. Each section was 25km in length. The total length of 265km was simultaneously laid and buried and to-date has not had a single fault. When considering that this is in one of the world's most heavily fished areas and crosses five offshore pipelines, this record should give some comfort to consideration of future potential schemes.

One of the tasks ahead is to match the developments made in the cable manufacturing section with a quality service to install and maintain repeaterless cables to a very high level.

It would of course be foolhardy to totally ignore the lessons learnt from past experiences, especially when dealing with what can be such a hostile environment. To this extent we in BT (Marine) are developing ISIS solutions that are tailored meet to individual specific requirements.

In order to drive down costs some installation companies have already experimented in other aligned markets with the "ship of opportunity concept". From this background many of the problem areas have already been resolved or are known when considering a non cableship solution. Obtaining a suitable vessel is a marine and engineering exercise normally undertaken by the experts in this field.

When selecting the right sort of vessel, innovation on equipment for cable handling will no doubt play a major part in the final choice. It is already very clear, that a totally new approach to cable equipment will have to be undertaken, that not only considers the product but is also matched to the vessel of opportunity concept.

Another task to be resolved is the subject of maintenance. In many cases, and for various reasons, the repeaterless system may not necessarily be incorporated into one of the existing maintenance agreements. One of the new tasks therefore is to examine in great detail a maintenance package that is tailored to the customers' needs. Unlike installation, which can be planned to occur during clement weather, maintenance cannot and usually a different set of parameters apply that take account of cable recovery in poor weather.

One of the main parameters to be considered, centres on the lower tensile strength of the new type of cables and their ability to be handled in deep water from a buried and unburied situation. The solution to this problem demands refinement to existing techniques of deburial and repair, pushing the experienced operators to their technical limits.

Quite often the equipment used to install a system is not, on its own, suitable for maintaining it. For instance the lay equipment is required to have a reasonably fast pay out and a burial system to match. On maintenance however, recovery and lay speed is not as important as having the ability to recover the cable, possibly by using a deburial tool/vehicle in the first instance. Then the cable is held during a lengthy jointing operation and the bight lowered back down to the seabed with probably a further reburial exercise.

To take into account all of these needs, it is necessary, at the system design and desk top study stage, to ensure that the installation and maintenance specifications are compatible and achievable.

An indication of the points to take into account are:

- Full survey

- Choice of route, including fishing, anchoring, depth of water, currents, seabed, shore-ends and siting of terminal station close to the land line. From this information a good indication of the various cable types required along the route can be established.

- Before addressing any burial criteria it is important to look closely at the optimum depth that affords good protection, is cost effective to install and can easily be maintained. If fishing is the main concern, it may be possible to divert the cable into deeper water away from the fishing areas and not burying at all.

- Ploughability of the seabed. In some instances it may be prudent to carry out a plough or burial survey. This is the means by which the cable burial depth can be determined, as well as the choice of the most suitable plant to achieve burial, vessel bollard pull required and expected plant wear.

- Equipment spread ability not only to install or maintain correctly within the mechanical specifications of the cable but also to take account of branching units.

- Mobilisation and demobilisation times cut to a minimum for cost efficiency, and in the case of maintenance, rapid response. This requires a new breed of equipment that, in the main, is containerised, fit for purpose, and robust to support the life of the system.

With these points in mind, we shall now consider various base deck layouts, that take into account the differing requirements for deep and shallow water installations, including maintenance.

3.0 ISIS SOLUTIONS

3.1 Introduction.

The present high investment levels for the equipment required to install and maintain a conventional fibre optic subsea cable system may prohibit such projects being undertaken. This in turn would result in no advanced communication system, or turning to an alternative method. However, the introduction of the smaller, more easily manipulated , repeaterless cable systems has paved the way to spawn a number of new, relatively low cost technical solutions.

The primary driver for any solution is overall cost effectiveness. This, together with the quality of the solution and the efficiency of use of the developed equipment, must satisfy the demands of any maintenance or installation requirement.

3.2 Installation.

The installation of the repeaterless subsea cables will prove to be far simpler than the maintenance. Maintenance and installation of subsea systems should be matched. The low cost installation of cables will prove to be ill advised if the system cannot be subsequently maintained.

The whole ISIS concept revolves around matched installation and maintenance and relies greatly upon the use of vessels of opportunity. The vessel chosen for a project will need to be suited to the task, or able to be economically modified to an acceptable standard. In addition it may be advisable to have the vessel available close to the region of the cable system. Vessel options include:-

- Supply Vessel.
- Fishing Vessel.
- Coaster.

- Barge (Dumb or powered)
- Pontoon.
- Modular cable Barge.
- A conventional cable ship where economical

For any of the above, equipment to be mobilised should satisfy the following conditions:

- Modular.

- Lightweight. i.e. can be handled easily at all likely mobilisation sites.

- Easily maintained.

- High operator skill levels not required.

- Have the ability to be mobilised at remote locations.

Figure 1 shows an installation spread. This particular spread is shown mounted upon a supply vessel. The main features of this system are that it is designed to be assembled in 2-3 days, with minimum specific vessel strengthening required. For shallow water working or where a cable memory retention problem exists, the use of linear belt/caterpillar type engines may be more appropriate than drum payout engines. In addition the components of the system satisfy the following criteria:

- All packages are designed to fit within a standard ISO 10ft or 20ft container frame size.

- The packages are reinforced so as to remove the requirement for deck strengthening or complicated scantlings.

- A repair facility is included within the spread to cover for such events as 'cutting and running' i.e. inclement weather.

The spread in Figure 1 does not provide a burial capability. However the addition of a burial system is straightforward and observes the following constraints:

- Greater burial depths, although routine, require the use of more robust and hence more expensive equipment. The degree of protection required should be determined, and matched to the cable characteristics (armoured/non armoured), soil types and seabed conditions. The cable can then be buried accordingly.

- The burial system is designed for handling small diameter, repeaterless cables, and to bury cable so that recovery for maintenance operations is achievable.

BT(Marine) has conducted trials to determine optimum burial depths to protect against many types of fishing gear. These have indicated that the trend for greater depths of burial may not be necessary, and that depths of less than 0.5m are sufficient. Figures 2 and 3 illustrate some of these trials.

A final consideration to be made in the system installation design, is to what water depth cables should be buried. Conventional systems are now buried to a soil depth of typically 0.6m, in water depths down to 1000m. For reasons of future maintenance, and the cost factor, the repeaterless cables should possibly not be buried to such depths. Decisions made with regard to installation standards could have important repercussions when the maintenance solution is constructed.

Figure 4 illustrates a modular installation spread with a burial capability based around a 'mini plough'. The main features of the plough system are:

- Modularised to fit within standard ISO 20' containers.

- Specifically designed for the burial of repeaterless cable types.

- Tow forces are minimised to extend the range of suitable host vessels.

- Features can include: joint burial, variable burial depth.

- Designed to plough from the beach, thus reducing the need for post lay burial operations, to relatively deep waters (approximately 800m).

The overall concept that should be embraced is that the installation should be as cost effective as possible, and able to be carried out in virtually any area of the world. The transfer of technology and local training should be encouraged to reduce installation and future maintenance cost levels.

3.3 Maintenance.

A well designed installation will offer the following benefits:

- Protection to the cable system.

- Maintenance solutions prior to installation.

- Maintenance requirements minimised.

A vast number of cable systems are maintained through international cable agreements. Where several such systems, including the new repeaterless type, exist in close proximity, an agreement solution could be the most cost effective. However where this does not apply, and the repeaterless system is remote, a cable ship may not be the cheapest and most viable solution. In developing economies of the world, cost and infrastructure constraints require alternative solutions. Additionally it is probable that a number of these systems will not have redundancy, and therefore rapid reaction times will be required. In order to achieve this goal the following methods will need to be employed:

- Maintenance equipment close to or in locality of cable system.

- Use of local skills to maintain and operate equipment.

- Use of locally available ships (assuming this is possible).

These methods will benefit local economies through the resulting training and where

Fig 1

[illegible] INSTALLATION SPREAD
WITHOUT BURIAL CAPACITY

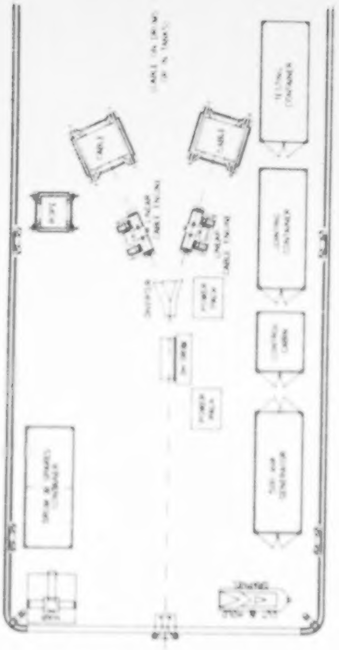
CABLE ON DRUMS
OR IN TANKS
TESTING CONTAINER
CABLE
CABLE
ROPE
LINEAR CABLE ENGINE
LINEAR CABLE ENGINE
JOINTING CONTAINER
DIVERTER
POWER PACK
CONTROL CABIN
POWER PACK
500 KVA GENERATOR
DRUM & SPARES CONTAINER

FIGURE 2: SMALL BEAM TRAWL TRIAL.
CABLE BURIED TO 0.3 METRES.

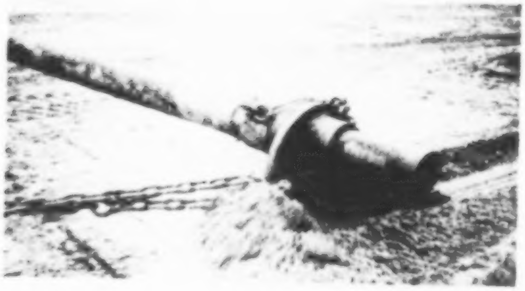

FIGURE 3: LARGE BEAM TRAWL TRIAL.
CABLE BURIED TO 0.3 METRES.

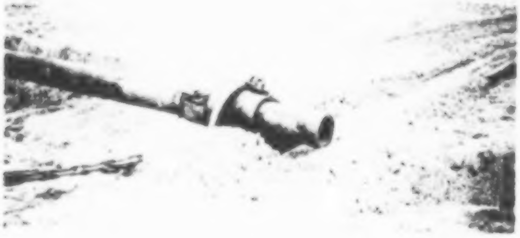

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Fig.4

ISIS INSTALLATION SPREAD
WITH BURIAL CAPACITY TO 600m DEPTH

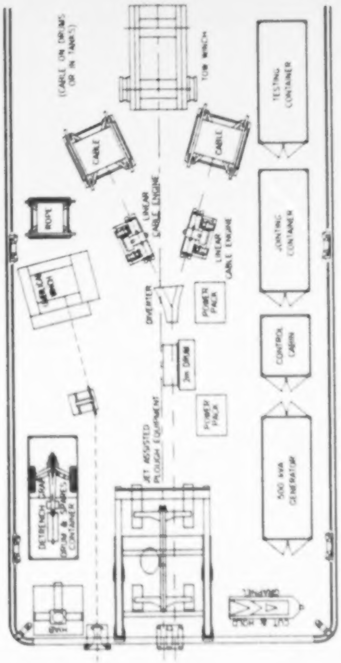
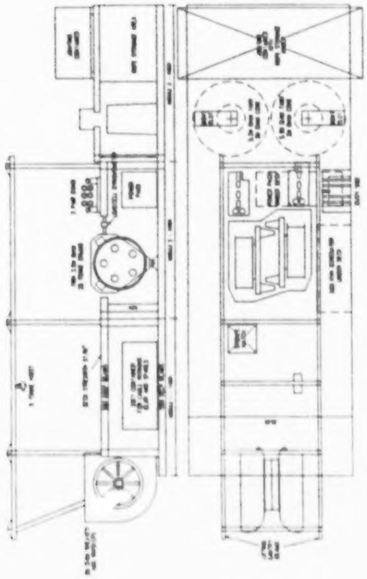

(CABLE ON DRUMS OR IN TANKS)
TOW WINCH
TESTING CONTAINER
CABLE
CABLE
LINEAR CABLE ENGINE
LINEAR CABLE ENGINE
ROPE
JOINTING CONTAINER
DIVERTER
POWER PACK
CONTROL CABIN
3m DRUM
JET ASSISTED PLOUGH EQUIPMENT
POWER PACK
500 kVA GENERATOR
DETRENCH GRAB
DRUM & SPARES CONTAINER
CUT & HOLD GRAPNEL

Fig.5

MAINTENANCE OF CONVENTIONAL TYPE CABLE FOR
SHALLOW AND DEEP WATER APPLICATIONS
BEYOND 20m DEPTH (FLATBACK SOLUTION)



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appropriate through purchase or hire of ancillary equipment such as cranes, generator sets etc.

The low cost nature of these systems require that maintenance solutions are not excessively costly. Equipment should therefore be value engineered, whilst ensuring that safety is still of paramount importance. The following paragraphs therefore address a number of key technical problems.

The key technical challenges are summarised as:

- Deep water and shallow water capability.
- Burial and Deburial: Cost effective recovery of cables.

3.3.1 Deep water and shallow water capability.

A cable maintenance system may require a deep water (greater than 800m), and/or shallow water (up to 800m water depth) capability. A number of solutions are shown in figures 5 through to 8. A discussion of these spreads, in the following sections, describes the rationale behind each scheme.

Conventional Type Cable: ISIS Repair Solution.

Figure 5 demonstrates the use of a supply vessel solution for the maintenance of conventional type cable systems. The advantage of this solution is that it is modular, allowing rapid mobilisation on a vessel of opportunity. The individual modules may be lifted or skated on to the vessel. The double deck arrangement of the modules lifts the exposed working areas away from the water and increases space, allowing the use of a smaller vessel than a single deck arrangement would call for.

Deep Water repeaterless cable maintenance system.

Figure 6 shows a possible deep water repair spread for systems with no cable burial. A small ROV is employed as an option to help detect the cable, cut it where necessary and attach recovery lines. In this way and especially near branching units, the cable can be safely cut, preventing any undue stress to the unit which could occur using other methods. It can also be seen that for deep water a sheave arrangement has been introduced, which helps to reduce cable wear.

Shallow Water Spread: Depths to 800m. (Figure 7)

This is an extension of the deep water repeaterless cable system, because it employs an advanced ROV such as the BT(Marine) Eureka. This allows maintenance of buried cable systems. However the system cost may be reduced by total removal of the ROV and employing a Detrench, Cut and Hold type grapnel for cable recovery and repair, and dispensing with a reburial option. The ROV may be then brought in at appropriate intervals to rebury a number of sections at one time.

Shallow Water Spread: Depths to 20m. (Figure 8)

This solution is barge mounted and employs equipment that would allow repair of virtually any cable system. However this system can be cost reduced by removal of the ROV and using the bed jet system with a diver to uncover cable and subsequently perform reburial.

One feature common to the maintenance spreads is the use of cable engines that are capable of the task in hand. The use of drums is encouraged to allow for high grappling forces and to hold cables safely. Often these drums are backed up with caterpillar engines which have a superior hold back performance than a similar sized wheeled machine. The small diameter of the cables used in repeaterless systems often causes problems when handled in conventional machinery.

3.3.2 Burial and Deburial: Cost Effective Recovery of Cables.

This subject has been the topic of considerable discussion. Figure 9 summarises various methods that may be employed to recover cables. The solution to be used will depend on a variety of factors: Cost, Depth of installation, Response time required, Cable burial depth, and Cable characteristics.

The usual governing factor in any maintenance spread will be cost. However this will be, to some degree, dictated by the cable characteristics, the water depth and the cable burial depth. Unfortunately some of the cables developed for the cheaper installations do not ease recovery: quite often the UTS (Ultimate Tensile Strength) is in the region of 5000 kg. This has the result that conventional recovery techniques may not be appropriate. An example of a recovery tool is the detrenching grapnel- a device towed on a wheeled chassis with long flukes that penetrate the seabed. Such a device will require relatively high towing forces for recovery of cable from the more deeply buried cable installations. The dynamics of the system may have the consequence of not being able to give enough resolution of towing forces to indicate whether or not a cable has been 'hooked'. Seabed conditions (i.e. sediment strengths) will affect this result. Stiff clays, for example, will increase the detrenching forces significantly and may cause the cable being cut rather than lifted to the surface. In fact, the analysis of forces required to lift a cable bight to the seabed from a buried condition, and indeed those for cable peel-out, is complex.

Figure 10 illustrates the conflict between the tensions in cable during recovery and typical breaking stress. Software and calculation methods exist to address these problems but there is no substitute for an actual full scale trial which can then be used to develop and refine the model further.

If a grapnel is not suitable for recovery of cables then some of the other tabulated equipment could be employed. However the use of ROV's is generally a costly exercise, and a customer may wish to avoid this. The alternatives are few: firstly the requirement

Fig.6

MAINTENANCE OF REPEATERLESS CABLE FOR DEEP WATER APPLICATIONS BEYOND 800m DEPTH (FLATBACK SOLUTION/NO BURIAL)

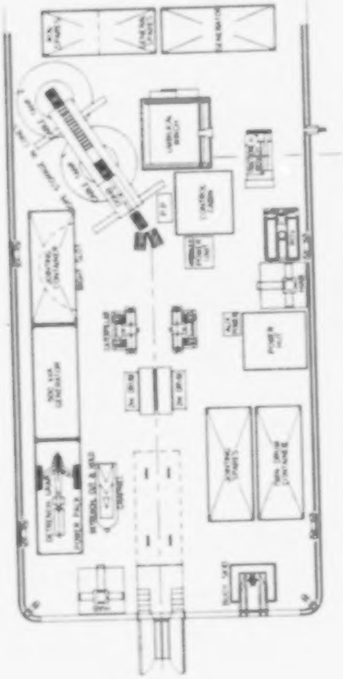
CONTROL CABIN
POWER PACK
800 kVA GENERATOR
CONTROL SPARES
SPIN DRUM CONTAINER
BIGHT SLOT
CATERPILLAR

Fig.7

MAINTENANCE OF REPEATERLESS CABLE FOR SHALLOW WATER APPLICATIONS APPROACHING 800m DEPTH (FLATBACK SOLUTION/OPTIONAL DEBURIAL & REBURIAL)

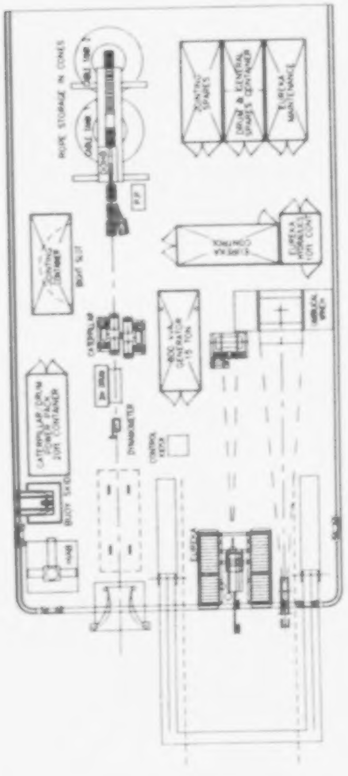
ROPE STORAGE IN CONES
CONTROL SPARES
DRUM & GENERAL SPARES CONTAINER
EUREKA MAINTENANCE
EUREKA CONTROL
EUREKA HYDRAULIC 10FT CONT
BIGHT SLOT
CATERPILLAR
800 kVA GENERATOR 15 TON
DYNAMOMETER
CONTROL KIOSK
CATERPILLAR DRUM POWER PACK 20FT CONTAINER
BUOY SKID
EUREKA

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Fig 8

MAINTENANCE OF REPEATERLESS CABLE FOR SHALLOW WATER APPLICATIONS APPROACHING 20m DEPTH (BARGE SOLUTION/OPTIONAL DEBURIAL & REBURIAL)

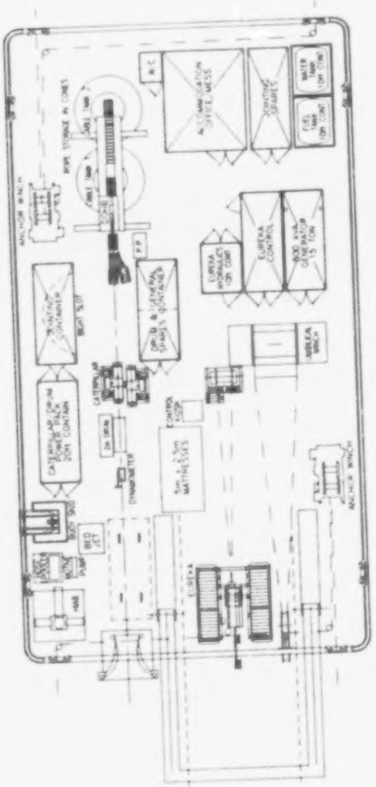

Fig 9: Methods of Cable Deburial

Deburial Method	Relative Capital Cost	Deburial Depths Possible			Advantages	Disadvantages
		Shallow (<20m)	Medium (20 -800m)	Deep (>800m)		
ROV	High	Yes. May also be able to perform in surf zone	Yes. But function of ability of ROV	Yes. > depths may incur problems with umbilicals	Versatile tool packages available Operates remote from ship Carries cable detection equipment Operates in a variety of depths	Relatively large deck spread required Large operating crew May be limited as to depth of deburial Maintenance intensive Transportation may be difficult
Crane plus Dredge Attachment	Low	Yes	No	No	Ease of operation Easily transported and mobilised Low maintenance costs Crane may be used for buoy launch and recovery, branching unit handling etc.	Stable operating platform required Limited depth capability Cable detection difficult Slow soil removal Diver required for lift line attachment unless appropriate grab equipment is provided
Submersible Dredging (Diver Operated)	Medium/Low	Yes. May be used up to surf zone	Not full range. > than 20m but not 800m	No	Rapid soil removal Diver operator can be used to detect cable and attach lift lines Rapid mobilization Low maintenance costs	Divers required and also appropriate support equipment (below 10m this is likely to be minimal). Saturation diving prohibitively expensive

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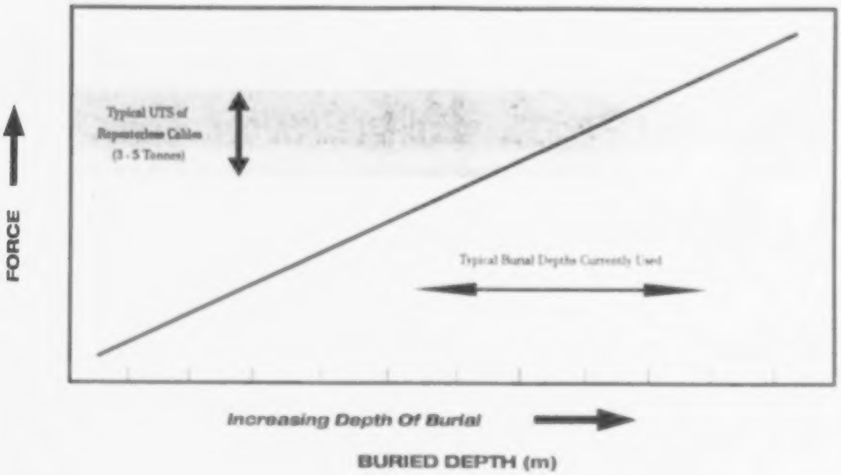
Fig 10: Force Required For Bight Extraction



for the amount of burial could be reassessed, together with the cable types to be used; secondly a unique deburial and cable recovery system may be employed. Such a unique solution exists in part: the enhanced cut and hold grapnel. This is a tool devised for recovery of deep water surface laid lightweight cables and has proven to be extremely effective. The tool is being taken a step further to be developed into a Detrench, Cut and Hold device. Preliminary trials have proven to be extremely encouraging.

The goal being sought from these developments is to provide the customer with a reliable, cost effective solution to enable maintenance of the less costly repeaterless cable installations.

4. REPEATERLESS CABLE SYSTEMS AND THE NEXT 10 YEARS

There is no doubt that with submarine repeaterless systems, we are at the dawn of yet another major advancement in the world of telecommunications.

This is seen by some fast developing countries as the only way to install their communications needs in a relatively short time, but so as to be long lasting and adaptable for growth. To these countries it is indeed the "missing link".

4.1 Installation.

As discussed above this missing link can be inserted by new and innovative installation methods that are cost effective. Over the next ten years this should allow the repeaterless submarine cable to become the main option to other terrestrial alternatives.

This cost factor can be adhered to by making sure that the specifications are not more than are actually required. The equipment modularisation concept will no doubt expand over the next ten years, in association with known vessels that are suitable for conversion. Many of these vessels can double for the maintenance issue, and a purchase or long term charter can be considered at commencement.

Recognition of some of the potential problems with repeaterless cable installation, eg cable looping, tension control, burial and extraction of buried cable from the seabed, reburial and general handling will obviously be monitored very closely. Solutions to these problems can be engineered and are not dissimilar from conventional cable problems.

Another of the exciting challenges to consider is the installation of branching units. These are certainly becoming more popular and can be used to enhance the versatility of a system as growth areas of population and business expand. BT (Marine) has recently installed a branching unit in the Mediterranean and has carried out a number of trials to establish a set procedure to suit vessels of opportunity.

4.2 Maintenance

As more and more systems are installed around the world the need for individual maintenance equipment will become less due to the pooling effect with other new and existing systems. In this way overall system maintenance costs should reduce and it is quite likely mini-agreements will spring up globally.

In order to meet this demand, companies with the existing maintenance infrastructure such as equipment and vessel management coupled with trained personnel are well placed. Similarly the operators, too, will benefit in this respect from technology transfer, as well as new developments that can be incorporated into their original maintenance spreads.

Obviously one of the most important issues for any new system is: how quickly can communication be restored in the event of a failure. In some locations it may be that a ring system does not require an immediate response, while in others it could become the life blood of the country. The degree of response will generally be proportional to what the operator is prepared to pay. For example a vessel mobilised with equipment and personnel held in the vicinity of the cable, is a lot more expensive than a modular repair spread held in a local port. It sounds so obvious but how many operators want the former whilst paying for the latter.

To this end a compromise can be made where the operator can buy into the maintenance building blocks that achieve the required end result. One should not forget that there is always the option of laying a completely new cable in the event of a fault, this may be more cost effective especially for short systems than to effect a repair.

One of the most expensive issues to contemplate is the one of deburial and reburial. Many of the major agreements in the world today have achieved this goal on conventional systems by employing very expensive ROV techniques. There are probably no short cuts to achieving this degree of safeguard other than an acceptance of reduced specification for reburial, no reburial at all eg heavier armouring on the repaired section, or innovative thinking and planning. It is in this latter area that the most development will be concentrated over the next decade.

The all important question on how much spare cable to order for a system that is expected to last around 25 years is one that will determine the size and location of the repair base. Over the next 10 years there could be a tendency for standardisation of cables, possibly as large manufactures amalgamate. In this respect, and coupled to new jointing technology, eg the BT(Marine), ATT, KDD and Alcatel consortium marketed Universal Joint, the need to store vast amounts of cable could be reduced. The actual repair and jointing equipment as detailed previously would require no more than a secure compound, preferably by a suitable quay side for rapid mobilisation.

In summary we believe the smaller repeaterless cable will become the norm. The equipment that the installation and maintenance industry put forward as a solution may not follow a common pattern. There will undoubtedly be times when customers will not be certain as to which contractors equipment or philosophy is best suited to the task. In this respect, as with all new developments, there will be a learning curve to go through. This can be short circuited by introducing a joint industry trials programme to investigate and resolve any potential key problem areas.

This new relationship between the turnkey contractor, the hardware manufacturer and the installer is of paramount importance because;

- the installation costs still form a high percentage of the overall system cost and, need to be reduced.

- the cable handling characteristics present novel problems and a close working relationship is needed for an integrated capability.

The experience of BT(Marine) regarding installation of repeaterless systems in the North Sea, Irish Sea, Iceland, Atlantic Provinces of Canada, Italy and Turkey, and working with partners to bid for future projects in many other parts of the world, indicates a new closeness of co-operation between the turnkey contractor and the installer. In most cases the system purchaser looks to the experienced installer like BT(Marine) to lend credibility to the system supplier. This is a new product and most purchasers are seeking reassurance and avoiding uncertainty.

THE GLOBAL COMMUNICATION HIGHWAY (OR BEYOND IRIDIUM$^{\text{TM/SM*}}$)

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Motorola
Chandler, Arizona U.S.A.

This paper describes a layered architecture of wireless technologies that can be used to bring modern communications to developing economies at costs that will be comenserate with ability to pay.

This paper will discuss an infrastructure architecture that will bring to every corner of the globe a modern state of the art telecommunications capability at a price that is affordable by developing countries and with a sophistication that meets the needs of the most advanced nations of the world.

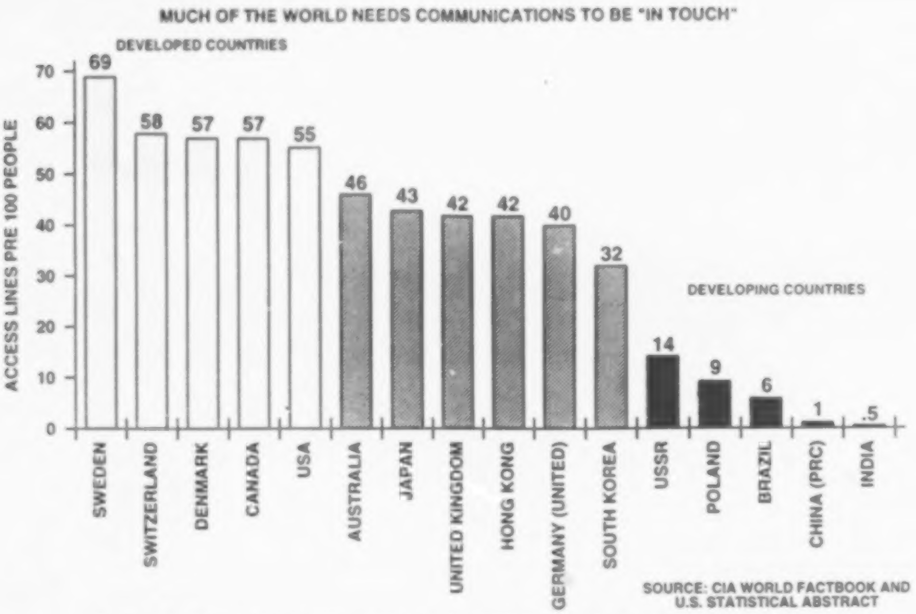
Clearly for developing nations to reach their full potential they must have access to advanced communications capabilities. Laying copper and optical fiber is fine for developed nations but the cost, and what is more important is the time required to bring developing countries the same capabilities prevent them from competing on an equal economic basis. The question is thus: how can telecommunication technology as the engine of change be used to breach the gap between the developed economies of the world and the developing economies of the world? A partial answer to this question lies in the greater utilization of wireless interconnection.

The Iridium network is designed to be a global telecommunications network that is capable of all the advance features of a fiber or wireline network. This paper will advanced inter satellite links forms the basis of a global infrastructure that is capable of giving developing economies the ability to leapfrog into the telecommunications main stream. The infrastructure investment required by each nation utilizing this core architecture is modest yet it will provide for advanced telecommunications features even in the smallest most remote villages. The architecture provides for intra-village inter-village and inter-country communication. The architecture recognizes that to be useful it must be affordable by the general population and capable of service expansion on the basis of an individual's need.

Wireless architecture can indeed lead to the rapid development of telecommunications and thus, economic growth within developing nations.

Wireline infrastructure has not penetrated developing nations to a great extent (see Figure 1). The problem that many of these developing nations face today is not one simple of just technology infusion but is also one of a social and economic barrier created by lack of access to communication services (i.e., information exchange). The question now is how best can these nations with underdeveloped infrastructure be bootstrapped into the full range of services soon to be provided over the various communication highways. Historically communications infrastructure was pushed out from the center of population concentration and thus grew like arteries in a growing body. However, with many developing nations there are many mature population centers and the communication arteries must be put in place after the fact. Though it is generally acknowledged that access to modern communication technology will quickly enhance economic growth, a degree of economic advancement is required to afford the sophisticated telecommunications infrastructure necessary to support the required services. Thus, the question becomes one of resolving this conundrum.

MOTOROLA
Satellite Communications Division



SOURCE: CIA WORLD FACTBOOK AND U.S. STATISTICAL ABSTRACT

FIGURE 1. WIRELINE INFRASTRUCTURE HAS NOT PENETRATED DEVELOPING NATIONS

MOTOROLA
Satellite Communications Division

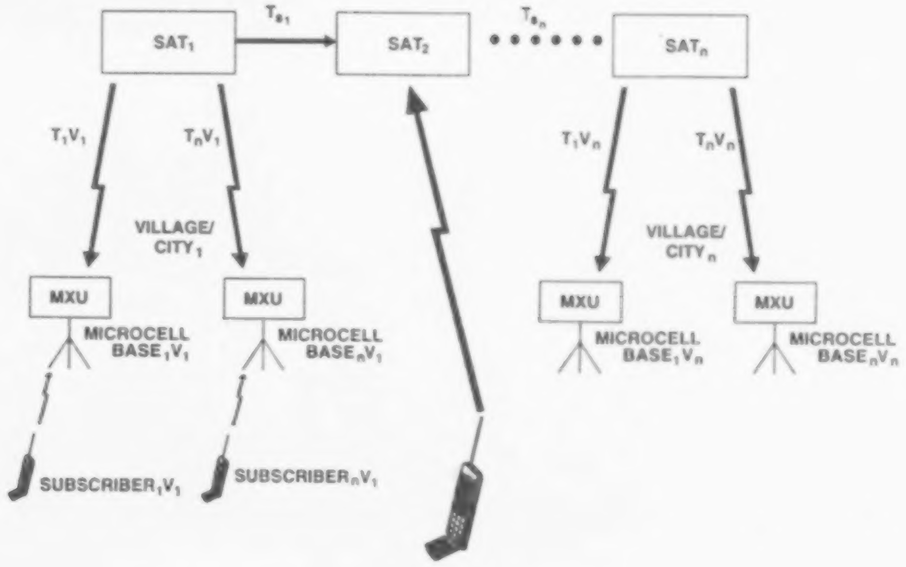

SAT$_1$
T_{s_1}
SAT$_2$
T_{s_n}
SAT$_n$
T_1V_1
T_nV_1
T_1V_n
T_nV_n
VILLAGE/ CITY$_1$
VILLAGE/ CITY$_n$
MXU
MXU
MXU
MXU
MICROCELL BASE$_1$V$_1$
MICROCELL BASE$_n$V$_1$
MICROCELL BASE$_1$V$_n$
MICROCELL BASE$_n$V$_n$
SUBSCRIBER$_1$V$_1$
SUBSCRIBER$_n$V$_1$

FIGURE 2. SYSTEM ARCHITECTURE

The capital cost to get fiber in the ground to those parts of the world that are under served may be logistically and economically prohibited. This point is further emphasized by the fact that wireless services are already experiencing tremendous growth in developing nations because the infrastructure requirements are much less. The emergence of PCS and other micro cell wireless technologies will further accelerate this phenomenon.

It is easy to envision that in many cities micro cell wireless technology will become the infrastructure architecture of choice for bringing communication services to the individual and the home. This architectural concept can be further extended through such systems as the Iridium system. Referring to Figure 2, an architecture is proposed that envisions intra-village connectivity via micro cell architecture; inter-village and inter-country connectivity through a space based switched network that interfaces with a specially designed wireless PBX. This architecture is a simple extension of the concept of cross linked satellites with on-board switching.

The Iridium system, as constructed today, supports this interlinked wireless architectural idea. Certain up grades in cross link technology is required to move

architectural idea. Certain up grades in cross link technology is required to move

the present thin route design to a thick route design. These technology enhancements are being studied presently and will be reported on in subsequent papers.

This paper shows that there exists an architecture consisting of a nested set of wireless technologies that can be used to bring rapid and cost effective telecommunication capability to developing nations and developing economies. The ability to bring communication bandwidth to every person on the globe is uniquely allowed by wireless technology. The addition of space based switched networks supplies the last brick to the architecture that completes the global vision of universal data access.

*IRIDIUM is a registered trademark and service mark of Iridium, Inc.

INMARSAT AND PERSONAL MOBILE SATELLITE SERVICES

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1. ABSTRACT

Project 21 is Inmarsat's overall vision and strategy for the evolutionary development of personal mobile satellite communications systems from now into the 21st century. Using advances in mobile satellite technology, it is aimed at introducing a range of affordable, increasingly portable and convenient, global personal mobile satellite communication services throughout the decade, that will bring mobile satellite services into the mainstream of mobile communications. Project 21 will lead to the introduction of Inmarsat-P service to handheld voice terminals by means of a new, more powerful, satellite generation dubbed P-Sats.

2. INMARSAT TODAY

Inmarsat is a financially successful and thriving global mobile satellite service partnership. Established in 1979 as a space-segment and system provider for global maritime-mobile satellite services, it started operations in 1982. In the eleven years since then it has evolved from a single market, single service system into a full-service global mobile-satellite system for all mobile user communities - maritime, aeronautical and land - with multiple services (See Tables 1, and 2). In fact, today, land mobile services already represents over a third of the organisations revenues.

- 1976 - CONVENTION ADOPTED
- 1979 - INMARSAT ESTABLISHED
- 1982 - GLOBAL SERVICE COMMENCEMENT
- 1985 - AERONAUTICAL AMENDMENTS
- 1989 - LAND MOBILE AMENDMENTS

Table 1. Organizational Evolution of Inmarsat

SERVICE	DATE	CHARACTERISTICS
Inmarsat-A	1982	Original voice / data
Inmarsat Aero	1990	terminal
Inmarsat-C *	1991	Aero voice and data
Inmarsat-M *	1993	Briefcase data
Inmarsat-B	1993	Briefcase digital phone
Global Paging	1994	Digital full service
Navigation	1995	terminal
Services	mid - 1990s	Pocket sized pagers
Audio	1998 - 2000	Variety of specialized
Broadcasting		services
Inmarsat-P		Possibility under
		exploration
		Hand-held satellite phone

** The launch of the Inmarsat-3 satellites in 1995 provides the opportunity to develop even more portable versions of Inmarsat-M and -C, cheaper to buy and operate*

Table 2. Evolution of Inmarsat Services

Inmarsat has been the chief architect behind the growth of mobile satellite communications. It operates globally but acts locally through Signatories and other service providers who supply Inmarsat services to end-customers. The steadily increasing membership of Inmarsat now encompasses 71 member countries. International ownership and control of Inmarsat ensures that the interests of all member-nations are reflected in the decision of the Organization. The Inmarsat Signatories, who are also investors in Inmarsat, represent the majority of the blue-chip telecommunications operators around the world, including 16 of the 20 largest international telecommunications carriers. About 60% of Inmarsat Signatories are also cellular operators.

The Inmarsat space-segment is available for peaceful, non-discriminatory use by all nations, whether members of Inmarsat or not. Currently over 31,000 mobile terminals commissioned by more than 160 countries use various Inmarsat services. Today, over 80 Land Earth Station (LES) "gateways" for different Inmarsat services are in operation worldwide, with many more being procured and planned.

For Inmarsat operations, the world is divided into four operating regions. Each operating region has its unique access code for telephone and telex. Each Inmarsat mobile has a unique ID, like a telephone number. Using access codes for the region in which a particular mobile is operating, an Inmarsat mobile can be addressed from PSTN anywhere in the world as well as by another Inmarsat mobile and can dial out to a subscriber connected to PSTN anywhere in the world or having another Inmarsat mobile.

Eleven satellites are in service at present, including four second-generation (Inmarsat-2) satellites launched during 1990-92. Even before deploying all Inmarsat-2 satellites, Inmarsat had proceeded to contract for third-generation (Inmarsat-3) satellites, whose service introduction is planned from 1995. Inmarsat-3 satellites will cover all of the internationally allocated 1525-1559/1626.5-1660.5 MHz L-band frequencies for mobile satellite services.

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They will also have considerably more power than the Inmarsat-2 satellites, will introduce spot beams for more cost-effective handling of new services traffic from regions of high traffic density, and will facilitate more efficient use of limited L-band spectrum through inter- and intra-system frequency reuse. In addition to the global beams, the combined coverage of the Inmarsat-3 spot-beams extends over practically all the global land masses.

3. PROJECT 21

Project 21 is an evolutionary programme designed to introduce, throughout the 1990s, a range of affordable, increasingly portable and convenient, global personal mobile satellite communications services. The early stages of this development have already occurred; transportable and portable of terminals in various existing Inmarsat service systems (suitcase-sized Inmarsat-A/B and briefcase-sized Inmarsat-C/M) are available now to serve personal satellite communications needs. With the introduction of the more powerful Inmarsat-3 satellites in 1995-96, it will be possible to have smaller, lap-top sized, Inmarsat-M terminals. Project 21 will lead to the development and implementation of Inmarsat-P, a global personal satellite communications system to hand-held terminals, and derivatives for maritime, aeronautical and semi-fixed applications. Inmarsat-P is being designed to provide voice and other services such as fax, data, paging and positioning.

The personal mobile satellite communications family is characterised by portable, increasingly more inexpensive terminal equipment, increasing efficiency in radio frequency (RF) spectrum use, lower usage charges and greater integration of terrestrial cellular systems. Existing and planned members of the family include:

- Inmarsat-A, in service since the late 1970s and providing, through some 40 gateways operating in various parts of the world, analog (FM) global telephony, voice-band data (upto 9.6 kb/s), fax and telex from suitcase-sized transportable terminals. Inmarsat-A also offers a 56/64 kb/s two-way, switched, high-speed data service option. Inmarsat-A transportable terminals are commissioned in over 135 countries. A digital companion to Inmarsat-A, known as Inmarsat-B and currently under introduction, is more spectrum efficient and substantially cheaper to use.

- Inmarsat-C, introduced in 1991 and providing, currently through 20 gateways, global data messaging communications from portable terminals. Eleven more LES gateways are now under implementation. There are 65 type-approved Inmarsat-C models for different applications, from 30 manufacturers.

- Inmarsat-M, under introduction now and providing digital voice (telephony), fax and circuit-switched data from small terminals, including briefcase-sized models. The initial service infrastructure is now available in all operating regions. End-user prices, for both terminals as well as services, are less than half those of Inmarsat-A, and these prices will reduce further as production volume increases. In fact, in some regions an end user charge as low as about US$3/minute is already in place.

- Global satellite paging, to be introduced in 1994 and providing a variety of paging services to pocket-sized receivers, receivers mounted on vehicles, and receivers integrated with briefcase Inmarsat-C and Inmarsat-M terminals.

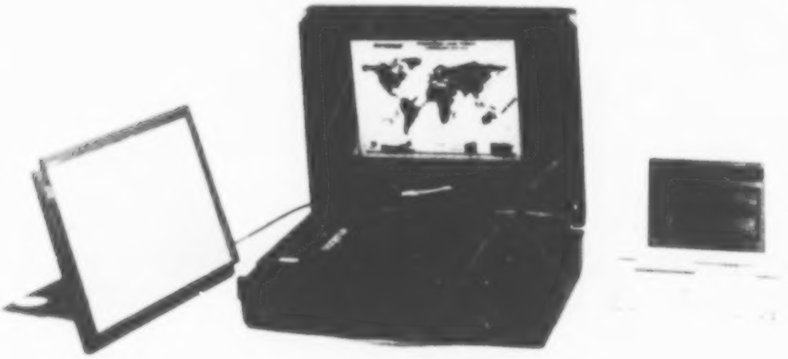
- Inmarsat-P, a global hand-held satellite phone, in planning for service introduction in 1998-2000 time-frame.

The existing and near-term services (Inmarsat-A/B, -C, -M and Paging; see Figure 1) in Inmarsat's portfolio of personal mobile satellite communications services serve as building blocks for the implementation of Inmarsat-P. The building block approach is important to the Inmarsat-P implementation strategy, since it helps minimize technical and financial risks, promote economies of scale and build up experience. The provision of Inmarsat-P service will require the addition of an advanced space-segment (P-Sat) and an associated terrestrial network infrastructure. The associated ground-segment infrastructure has to be capable of supporting the satellite-phone service on a stand-alone and global basis as well as in national/regional cellular extension mode.

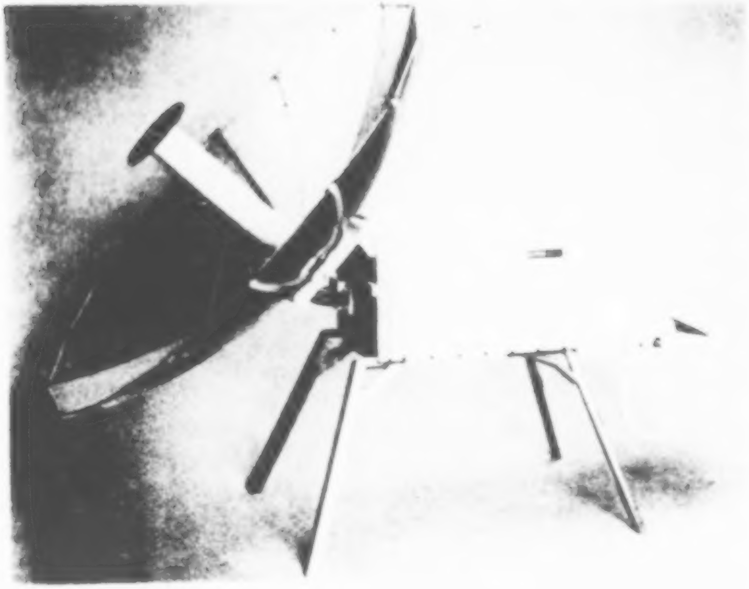
The implementation of an increasing number of personal mobile satellite communications services throughout the 1990s will expand the nature and scope of mobile satellite communications, from services designed principally for relatively small niche markets to those which will attract considerably larger, worldwide markets. These services provide an important complement to terrestrial mobile services by reaching areas where terrestrial mobile services either do not or cannot reach economically and by providing a global standard that can operate across regions of different, incompatible, terrestrial standards.

Inmarsat plans to enhance these personal communications service offerings, even before introduction of Inmarsat-P, as technological developments permit. With the introduction of the more powerful Inmarsat-3 series of satellites with spot-beams in 1995-96, already under construction, it will be possible to offer the market several smaller and/or lower-power versions of Inmarsat-M.

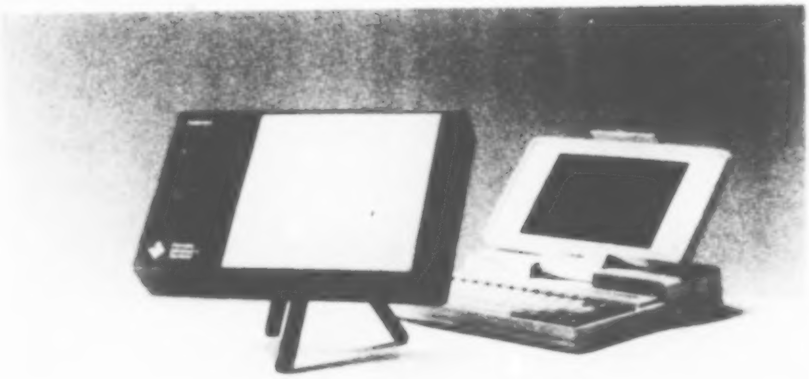
FIGURE 1
EXISTING INMARSAT FAMILY OF PERSONAL
MOBILE SATELLITE TERMINALS



A BRIEFCASE
INMARSAT M



A SUITCASE
INMARSAT A



A BRIEFCASE
INMARSAT C

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An important consideration is to ensure that personal mobile satellite communications services function with other existing and evolving communications systems as an integral part of the worldwide communications infrastructure. Satellite-cellular interworking, being designed into Inmarsat-P, is under consideration for Inmarsat-M as well. Features such as smart or IC cards and single number access may be incorporated as they are introduced into the worldwide communications systems. Inmarsat is actively participating in the international technical standards and technical bodies working in these areas.

The evolution of the family of personal mobile satellite communications services and communications networks will have an important part to play in the subsequent introduction of Inmarsat-P. It paves the way by responding to near and medium-term market needs for portable voice and data long before the arrival of the hand-held phone, builds markets, puts in place and acquires operational experience with an advanced network infrastructure and mobility management, and increases integration between satellite and terrestrial services. More importantly, the evolutionary approach helps put in place, brick by brick - because that is what it takes - the commercial and operating frameworks and conditions (e.g., local service arrangements and distribution links, class licensing and transborder operation of MSS terminals, accounting, billing and call routing, interconnect) on a wide basis that are prerequisites for enabling an early large build up of subscribers and traffic base. Without the feasibility of rapid build up of very substantial subscribers and traffic base, the large, heavily upfront loaded and long gestation period investments in handheld satellite phone systems will not be profitable.

4. INMARSAT-P

Inmarsat's planning for hand-held satellite-phone (Inmarsat-P) service has been market driven and began with no preconceived notions of a preferred satellite system or orbital configuration. The design philosophy behind Inmarsat-P calls for a system that features good performance, manageable complexity, low cost, high reliability, and rapid implementation and which above all meets the needs of its customers, i.e., service to small and safe hand portable phones. In its search for the best possible technology, Inmarsat began, paradoxically, with the market first, not the technology.

Inmarsat's approach has been that of an operator who will make the most cost-effective buy of whatever technology/system is determined to have the best business match with the markets. Inmarsat and its investors and service providers get their returns from service provision and not from sales of satellite and other hardware/software. Consequently, a thorough understanding of the prospective markets, alternative system solutions, and the particular attributes of handheld service delivered by different satellite constellations have naturally underpinned the Inmarsat process of evaluation of the business potential and selection of the preferred satellite system. Inmarsat investors, representing the majority of world's premier telecommunications operators, are a knowledgeable and discerning lot who very critically appraise new investments from a hardnosed business perspective.

Fortunately, we are lucky to be in a time of a 'buyer's market'. There is such a wealth of choice and creativity, i.e., there are many different ways to provide the handheld satellite phone service as evidenced by the many proposals for hand-held satellite phone service.

However, the risks are high. The investment involved is large; it takes several years from the commencement of investments before the first revenues come; there are major risk potentials that need to be suitably managed; and competition is inevitable. It is vital that a right system choice is made to offer the most competitive cost-performance package suited for real-life operating environments.

Inmarsat has put considerable effort into understanding service attributes and characteristics through different satellite systems and associated orbital configurations (especially the notion of "user cooperation" involved in establishing and maintaining a communications link), the limitations as well as advantages vis-a-vis terrestrial cellular service, associated customer preferences and markets and the feasibility, critical technologies involved, costs and implementation schedules of different advanced satellite system solutions to deliver the service to a "safe", low-power, hand-held terminal. In a flat and open terrain and unshadowed environment, all space system solutions offer the same performance, except for transmission delays unique to each orbit configuration, and do not need any significant, if any, user cooperation. But as one evaluates real-life operating environments with shadowing by vegetation, buildings etc, the differences in the system performance and the user cooperation needed stand out.

Unlike today's local / regional and multiple-standards cellular systems, the hand-held satellite-phone offers a single worldwide standard. However, compared with cellular, it will cost considerably more in terms of equipment and usage, will require considerably more user cooperation and will not have the same in-building penetration. It essentially provides a line-of-sight voice service to and from hand-held terminals on or above the earth's surface. Within buildings, voice service may be possible close to appropriate windows, depending on the orbit design, link margin and the degree of build up of the surrounding environment. However, the "call announcement" and "paging" functions, with much higher link margins, would have significantly higher in-building availability. Table 3 gives a comparison of handheld satellite and terrestrial cellular.

	Cellular	**Satellite**
Size:	Hand-Held (now)	Hand-Held (~ 1998)
Quality:	Digital Cellular	Digital Cellular
Availability:	In buildings	Largely Line of Sight
Coverage:	Local, Regional	Global
Standards:	Multiple, Incompatible	Single, Worldwide
Costs:		Equipment and usage more expensive than cellular

Table 3. Handheld satellite Service - Cellular comparison

Designing the system for adequate service availability for the intended markets is a key consideration. There are two distinct approaches to improving satellite phone service availability:

- Single path, 'medium power' (16-17 dB link margin)

- Multiple path (Satellite Diversity), 'low power' (7-8 dB link margin)

The latter requires more satellites, but each with considerably reduced size and complexity. Inmarsat's techno-economic analysis favours exploitation of the advantages of satellite diversity as a more cost-effective approach.

Table 4 describes the main features of the Inmarsat-P hand-held terminal and associated services; Figure 2 gives an illustration of a model of Inmarsat-P as visualised by a well known cellular manufacturer.

Inmarsat-P Markets

The primary markets, as determined by an extensive programme of global market analysis and market research, taking into account the different characteristics of the satellite hand-held phone vis-a-vis the cellular phone, are:

- International Business Travellers (IBTs), who are internationally mobile across cellular standards or cellular coverage gaps or to areas where their communication needs are not satisfied by terrestrial alternatives

- National Roamers: Business travellers who roam nationally into areas where cellular coverage is not available

- Cellular Extension: Business people resident outside cellular coverage

Baseline:	Voice with quality similar to today's digital cellular service, integrated with home region digital cellular (GSM/ADC/PDC); Medium penetration call announcement
Size:	<300 cm^3
Weight:	~300-450 grams
Battery Life:	Idle mode: 24 hours (paging mode 160 hours) between handset charges Talk mode: 1 hour minimum
Retail Cost:	Approx US$ 1500 for a dual-mode satellite/cellular handset
Optional Standardised Services and Features:	High penetration paging Duplex data compatible with asynchronous V22 bis Group 3 fax compatible (quasi real time) Position determination Internal buffer for data, paging and fax Smart card Expansion port for peripheral devices and car cradle

* Other variants, eg; vehicular, maritime, aeronautical, will be available, but do not have same impact as handheld product on system design

Table 4. Inmarsat-P Handheld Terminal*: Main Features

In addition, certain ancillary maritime, aeronautical, trucking, and semi-fixed markets can be expected. Market size and utilization, except to a certain extent for IBTs, are quite sensitive to user equipment and usage costs. At US$ 2/minute for the end-user charge, a total addressable worldwide market in the order of 5 million subscribers in all market segments by the year 2010 is forecast for hand-held satellite phones. With most of these terminals being "dual-mode" satellite-cellular, and with satellite service being the "second" option accounting for the minority of overall communications, satellite utilizations are expected to be significantly lower than is currently the case for cellular phones.

Inmarsat-P System Solutions

Three major options for the Inmarsat-P satellite System (P-Sat) have been under extensive evaluation:

- An enhanced geostationary (GSO) satellite system, orbiting at 36,000 km similar to the orbital configuration of Inmarsat's existing satellites, but more powerful, with larger antenna and incorporating a very large number of small spot-beams

- An intermediate circular orbit (ICO) satellite system, with between 9 and 15 spacecraft orbiting at about 10,000 km

- A low earth orbit (LEO) satellite system - now no longer under consideration - comprising 54 operational, but relatively smaller satellites at about 1,800 km

In the Project 21 Phase-3 work programme, which was completed in June 1993, contracts were awarded to major aerospace companies around the world to refine further and to optimise each of the three orbital configurations under analysis using standard service performance criteria, as well as the characteristics of the hand-held terminals, transmission power requirements and service capabilities. The following aerospace companies were involved:

- GSO
  - Hughes Space & Communications (USA), with NEC (Japan) and BAe (UK)
  - Martin Marietta Astro Space (MMAS, USA), with Matra-Marconi (UK & France)
- ICO
  - Matra-Marconi (France & UK), with MMAS (USA)
  - TRW (USA)
- LEO
  - Alliance Consortium made up of Aerospatiale (France), Alcatel (France), Alenia (Italy), and Deutsche Aerospace (Germany)
  - Antrix (India), with Indian Space Research Organization (ISRO)

Table 5 summarizes the candidate satellite systems configurations for the delivery of Inmarsat-P service analysed by Inmarsat; it is important to note that each of these satellite systems are designed to provide service to the same specified hand-held terminal described earlier. The techno-economic evaluation performed by Inmarsat has indicated that designs for all configurations are technically feasible. The major differences among the systems are in terms of costs, implementation schedule, relative spacecraft vs system level complexities and critical technologies, replenishment cycles, the nature and level of user cooperation required and service quality. Our analysis determined that LEO has the highest cost, very long introduction time, shortest satellite life-time and thus the shortest replenishment cycle, variable user cooperation, complex ground-segment, and poorest rate of return. From Inmarsat's own technical, operational and financial viewpoints, therefore it is significantly inferior to the other (GSO and ICO) configurations.

GSO configurations have the lowest capital investment (but still of the order of US$ 1.5-2 billion) and nominally the highest rate of return, but involve highly complex spacecraft payloads and a service availability and performance which is not as good as those obtainable from a suitably designed ICO constellation. A responsive ICO constellation has considerably higher cost than GSO, but offers superior service.

	GSO-P*	**GSO-C***	**ICO**	**LEO**
Orbit Type	Circular	Circular	Circular	Circular
Orbit Height (kms)	3600	36000	10355	1800
Inclination (degrees)	0	0	50.7	55
No. of Operational Sats	4 or 6	4 or 6	12	54
Services	Inm-P	Inm-P + Exist	Inm-P	Inm-P
No. of Spot Beams	200	140 + 61	85	19
Antenna Diameter (metres)	6	6	1.2/1.8	around 1m
Channels per Sat.	5000**	5000* + Exist	4000	1500
Satellite RF Power (W) for Mobile Link	700	300 (excluding existing services)	600	200
Mobile Link (GHz)	1.6/2.4	1.5/1.6	1.6/2.4	1.6/2.4
Feeder Link (GHz)	3.6/6.5	3.6/6.5	20/30	20/30

* GSO-P dedicated to Inmarsat-P services; GSO-C (combined) will also carry all other Inmarsat services

** 4000 channels / satellite for 6 satellite configuration

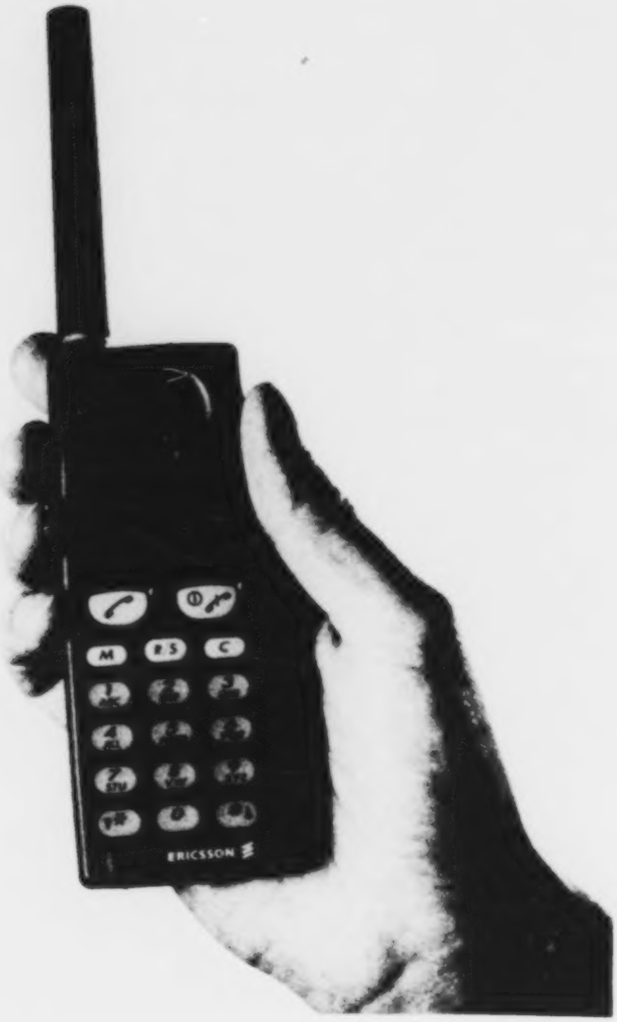
Table 5. Summary of satellite system options analysed

Inmarsat-P: Next Steps

After a careful consideration of the Inmarsat-P market, technical and financial evaluations carried out in Phase-3 (November 1992 - June 1993), Inmarsat Council, the governing body of Inmarsat decided, in its July 1993 meeting, the following:

- To confine further consideration to GSO and ICO system configurations only and to cease further consideration of the LEO configuration;
- To commit to the selection of the preferred system configuration at its February 1994 meeting;
- To institute a work programme (Phase 4) through to the end of 1993, and in time for its February 1994 meeting, to facilitate the selection process and, concurrently to examine related service commercialization issues;
- To initiate, immediately after the February 1994 decision, appropriate major Technology Validation Programmes as an integral part of the system procurement strategy, in order to retire key technical risk areas early in the implementation programme.

FIGURE 2
A MODEL OF INMARSAT-P HANDHELD TERMINAL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Inmarsat-P: A worldwide, cooperative effort

The development of Inmarsat-P is a worldwide, international endeavour which relies on the cooperation and expertise of Inmarsat Signatories, the aerospace industry, telecommunications companies and organizations, equipment manufacturers, space segment manufacturers and professionals around the world.

Memoranda of Understanding and agreements have been reached with a number of the world's foremost mobile equipment manufacturers to draw on their expertise in terminal and network technologies, and with leading spacecraft manufacturers in the development and evaluation of satellite system technology.

The result of this extensive collaborative effort will be a global service, supported by the world's major telecommunications operators, that will revolutionize the way we communicate. In all of these developments, the starting point and the driving force have been, and will remain, the needs of the customer.

AN UPDATE ON THE DEPLOYMENT IN THE PACIFIC RIM OF THE ORBCOMM DATA COMMUNICATIONS AND MESSAGING SYSTEM

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Dulles, Virginia, U.S.A.

ABSTRACT

During this year, the first of the new low-Earth orbit data satellite data communication systems, ORBCOMM, will become operational. It will be available initially in the United States, but because the costs of the equipment and the usage will be very low and affordable, coverage is expected to grow rapidly, especially around the Pacific rim. This paper provides an update on its development and deployment.

ORBCOMM is one of the new mobile, two-way, satellite based, data communication systems being readied for use around the World. At this time, the first two of the 26 satellites are being built for a launch scheduled during the second quarter of 1994. The ground segment for the U.S. network is nearing completion and the first of the user terminals are being delivered for deployment in the field. ORBCOMM will be offering intermittent service in the U.S. as early as next Fall, with full service early in 1996, after the other 24 satellites are launched. Similar service will be available in other Pacific countries shortly thereafter. Thus, ORBCOMM has moved from a theoretical concept to a practical operating system and we are now entering a period when communication planners should, and indeed are, taking it into account when deciding upon their options.

Although many in this audience are undoubtably already familiar with the concepts of the "Little LEO" systems, of which ORBCOMM is one, I will briefly describe them and then concentrate this paper on the steps which have been taken to reach this imminent launch position, the system status and the plans and schedules for deployment in the Pacific.

Little LEO's are communication systems that transport data between a users's fixed base station and any of his remote and/or mobile field locations. Ubiquitous coverage is provided by satellites in low-Earth orbit which relay the messages between Gateway Earth Stations and the remote terminals using VHF radio. As shown in Figure 1, connections between the Gateways and the Network Control Centers are by dedicated duplex circuits, which may be on cable, microwave or geostationary satellite links. Connection between the Network Control Center and the users' base stations will be provided by the Public Switched Networks.

The term "Little LEO" has been coined to distinguish us from the "Big LEO's" which are designed for voice traffic rather than data. Compared with these Big LEO's, the data-only Little LEO's have a smaller number of smaller satellites, use the lower frequency VHF signals rather than the microwave signals, and generally are much lower cost. And cost is the most critical factor here. Lower cost means greater affordability, and although this is a characteristic important to everyone, it is vital for most of the Pacific rim countries, for whom many recent technological advances in communications have been of limited applicability, since they have been concerned with making things better, but not always cheaper.

The ORBCOMM system will use pocket-sized user terminals, called communicators, which generally are of two basic types. One will be used at unattended locations, and will have a machine-to-machine interface with other equipment. It will be used for SCADA, or Supervisory Control and Data Acquisition, applications so that remote assets can be monitored and controlled from a base station. The other type of communicator will be for personal communications in the field, and will have a key pad for data entry and a screen for displaying received messages. A typical unit is shown in Figure 2. The cost of these units will be low, with the more expensive personal communicator retailing at about U.S.$400.

Messages will be packetized (by the ORBCOMM system and not by the user), and sent at a bit rate of 4800 bits per second in outbound direction, to a remote communicator, or 2400 bits per second inbound from the remote unit. The system will include error detection and packets will be resent if required.

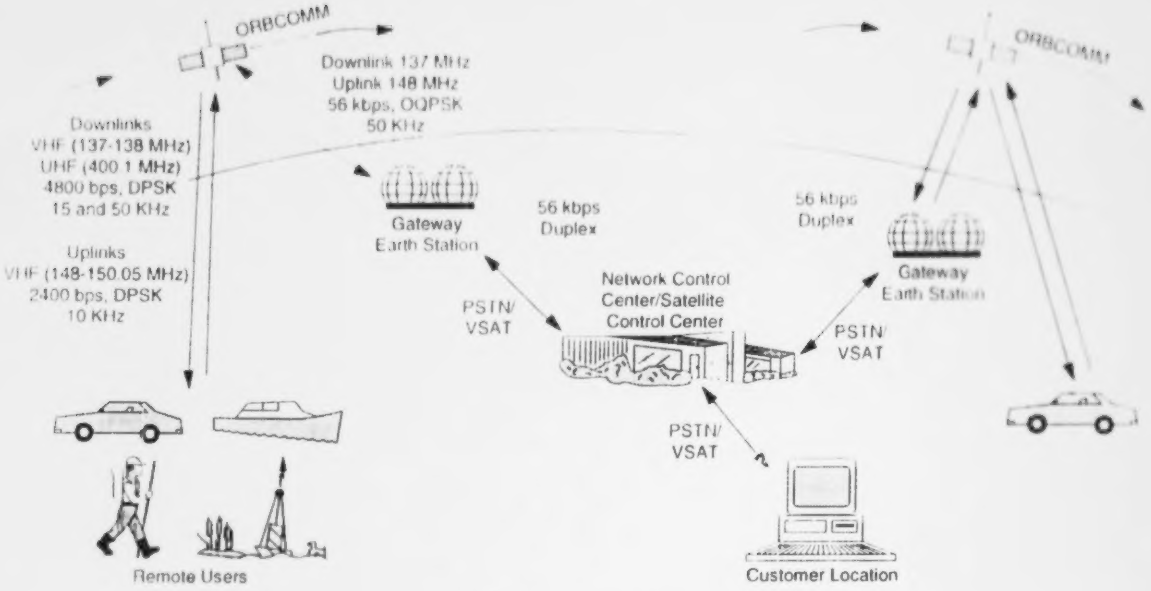

ORBCOMM
Downlink 137 MHz
Uplink 148 MHz
56 kbps, OQPSK
50 KHz
ORBCOMM
Downlinks
VHF (137-138 MHz)
UHF (400.1 MHz)
4800 bps, DPSK
15 and 50 KHz
Uplinks
VHF (148-150.05 MHz)
2400 bps, DPSK
10 KHz
Gateway
Earth Station
56 kbps
Duplex
56 kbps
Duplex
Gateway
Earth Station
Network Control
Center/Satellite
Control Center
PSTN/
VSAT
PSTN/
VSAT
PSTN/
VSAT
Remote Users
Customer Location

Figure 1. ORBCOMM Network Topology

Generally, the communicators operate in a near real time mode and so require that a satellite be simultaneously in view of both the remote communicator and a Gateway Earth Station. There will be outages when this condition is not met, since the number of satellites has been kept low to achieve low cost. However, packet data systems, even two-way systems, are inherently tolerant of short outages (as opposed to two-way voice systems which are conversational and cannot be interrupted in the same way). Short frequent outages, which will appear as transmission delays, are an acceptable price to pay for system affordability.

There will also be a small capacity for a store-and-forward mode of operation, which could have some limited use for communications with remote units in the mid-Pacific and in the polar regions, where it is impractical to build Gateway Earth Stations.

ORBCOMM is not being set up as single worldwide network, but rather as a large number of national networks, each of which has its own control center and one or more Gateways, and which use the satellites on a time-shared basis as they orbit the world. Also, it is used together with the existing public switched network infrastructure. ORBCOMM facilities connect the remote units in a country with that country's network control center, and the PSN carries the traffic between the NCC and the user's base station -- either the domestic PSN for a base station in the same country or the international networks for transborder traffic to foreign base stations.

In addition to carrying data, the ORBCOMM communicator units can also determine their position, using measurements of the doppler shift on the downlink signals, The accuracy of position will be in the range of 300 to 1000 meters, and from a "cold start", several minutes of doppler measurement are required to converge on a solution. For many applications this is satisfactory, especially since it is an additional service at no significant additional cost. For those users requiring more accurate or faster position determination, a GPS receiver would be used, with ORBCOMM providing the means to communicate that position.

The process to reach the current status has been both complex and rapid. At the outset, there was no VHF spectrum allocated for mobile satellite service (MSS). VHF is desired to minimize system cost, and especially communicator unit cost. Also, the up and down link frequencies have to be close enough to allow use of a single receive and transmit antenna on the communicators. Two bands were selected -- 137-138 MHz for downlinks and 148-150.05 MHz for the uplinks. Reallocation of these bands for MSS (shared with existing users of the spectrum) was placed on the agenda of the 1992 WARC meeting, within one year of that meeting, and agreed upon at the WARC on a worldwide basis, with minor exceptions by some of the Administrations. By comparison with the more usual time table for making changes to the ITU Table of Frequency Allocations, this was a remarkable feat and reflects the importance placed on this service by all countries around the World.

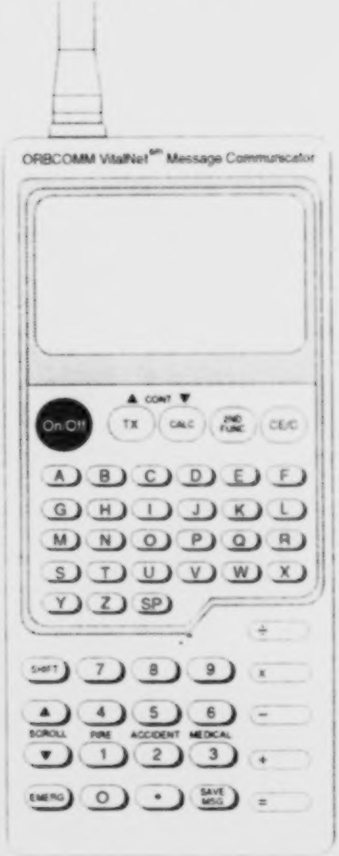


Figure 2. Communicator Unit

The next step after WARC is for individual countries to make the corresponding changes in their own frequency allocation rules and to authorize system operation within their borders. The complexity of this process differs from country to country. In the U.S., the frequency reallocations were made in January 1993, less than one year after WARC, and the three applicants (ORBCOMM, Starsys and VITA) are expecting to receive full operating licenses in the first quarter of 1994. As a result of this pioneering work by the FCC, similar actions by other Administrations are expected to follow fairly rapidly. It should be noted that country by country approval to operate the transmitters on the satellite is not required, since the power flux density of the downlinked signals at the Earth's surface will be below a threshold set by the WARC at which coordination is needed. Individual country authorization is needed only for building the Gateways and using the communicators within its own territory.

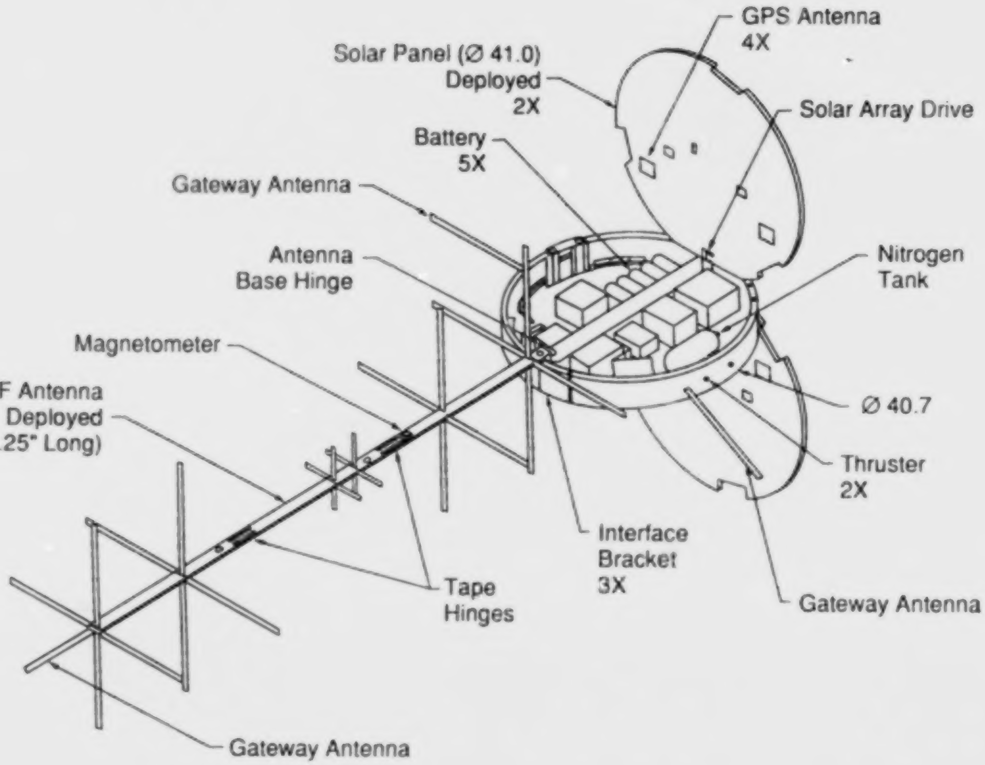
The system design and development has proceeded without any major hitches. There was the major challenge to design the satellites within very tight size, mass and cost constraints, and this was successfully met by Orbital Sciences Corporation, the parent company of ORBCOMM, which has developed a low-cost satellite weighing only 39 kg (see Figure 3) and physically small enough so that eight of them can be launched together on one Pegasus rocket, as shown in Figure 4. The low-cost to build and launch these satellites has been key to deploying an affordable system. A similar accomplishment was made by the Panasonic and Elisra companies in Japan and Israel, who have each designed and developed the small, light-weight communicator units and will be manufacturing and marketing them at prices below U.S.$400.

From the radio point of view, ORBCOMM has been designed so that it can share the allocated spectrum with the existing users (principally terrestrial paging and push-to-talk radios) and with other Little Leo's. It is essentially a narrow band FM system. Signal levels on the downlink are, as earlier mentioned, sufficiently low that they will not cause unacceptable interference, and the number of terrestrial transmitters that can input interfering energy into an ORBCOMM communicator is limited by VHF propagation conditions along the Earth's surface.

Interference in the uplink band is a more difficult problem. ORBCOMM has solved this by using frequency hopping, or what is more formally called the Dynamic Channel Activity Assignment System (DCAAS). In essence, each satellite continuously scans the 148-150.05 MHz band and records the received signal power in 2.5 KHz steps. It uses these measurements to select a small number of 15 KHz wide channels which are likely to be unused by other systems within its footprint within the next few seconds of time. These channels are assigned to the communicators which have the capability to change their transmit frequencies rapidly and accurately.

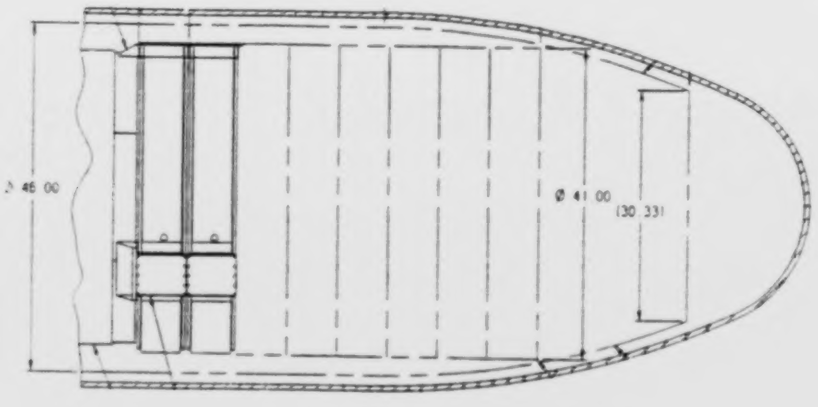
As with all modern communication systems, the entire network is computer controlled and indeed much of the development work has been dedicated to software rather than to hardware. The core software has been written and exhaustively tested in simulation. It will be used in each Network Control Center. There is also a growing amount of applications software being adapted for ORBCOMM or written specially for ORBCOMM. This will be an on-going process, and by no means limited to Orbital Communications Corporation. It is to be expected that users and value added resellers throughout the World will be developing applications software themselves, for their own use and for sale to others.

Whereas Orbital Communications Corporation will itself own and operate the U.S. network, elsewhere in the World this will be done by local companies operating under license. These licensees will own and operate



GPS Antenna
4X
Solar Panel (Ø 41.0)
Deployed
2X
Solar Array Drive
Battery
5X
Gateway Antenna
Antenna
Base Hinge
Nitrogen
Tank
Magnetometer
VHF/UHF Antenna
Deployed
(105.25" Long)
Ø 40.7
Thruster
2X
Interface
Bracket
3X
Tape
Hinges
Gateway Antenna
Gateway Antenna

Figure 3. ORBCOMM Satellite in Deployed Configuration



Ø 46.00
Ø 41.00
(30.33)

Figure 4. Eight Satellites Stacked for a Pegasus Launch

their own ground segment (a Network Control Center and one or more Gateway Earth Stations), and market the services in their country, including setting their own tariffs. They will all use the orbiting satellites as they appear in view, for which they will pay a satellite access fee to Orbital Communications Corporation. It is important to note that each network is self contained and controlled. Messages are not transmitted or relayed back to any other network.

At this time, provisional agreements have been made with potential licensees in 19 countries, most of which are in the Pacific rim. They are listed in Table 1. During 1994, many of these agreements will be replaced with formal License Contracts, and the licensees will begin installing their ground segment equipment, hiring and training staff and be ready to offer service starting in 1995 or 1996. The number of countries with operating ORBCOMM networks is expected to grow rapidly in the next three to four years.

ORBCOMM is a purely commercial venture, without any form of government funding. During 1993, Orbital Sciences Corporation, the American company which founded ORBCOMM, joined with the Canadian company Teleglobe. These two are now joint partners in the project. Orbital provides the expertise in building and launching the satellites and Teleglobe its extensive background in international communications, and together they are financing the program.

ORBCOMM is not the only Little LEO system and also, for certain applications, mobile data service can be equally provided by other types of communications. However, and this is of particular relevance to the Pacific Ocean counties, it has the unique capability to combine ubiquitous coverage with affordable prices, and it is doing that now and not at the end of the decade.

Table 1. ORBCOMM Candidate Licensees

COUNTRY	CANDIDATE LICENSEE
Argentina	Teleinformatica, S.A.
Bolivia	Teledata, S.R.L.
Brazil	ABC Dados Informatica, S.A.
Chile	ENTEL
China	Champion Technology Ltd.
Colombia	Vipercom, S.A.
Ecuador	Sistel, S.A.
Guatemala	Telesistemas, S.A.
Honduras	Compania TV Hondurena, S.A.
Hungary	Muszertechnika, Rt.
Indonesia	P.T. LEO Nusantara
Israel	Elisra Electronic Systems Ltd.
Japan	Okura & Co. Ltd.
Mexico	IUSA
Panama	ORBCOMM de Panama
Peru	ENTEL
South Korea	Samsung Co. Ltd.
Uruguay	Teleinformatica, S.A.
Venezuela	C.A. Telecomunicaciones de Caracas

SATELLITE AND MOBILE SOLUTIONS FOR TELECOMMUNICATIONS DEVELOPMENT

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Washington, D.C., U.S.A.

ABSTRACT

Much of the developing world remains woefully underserved by telecommunications, but technology will increasingly offer solutions that will help to "jumpstart" the engine of development. Terrestial mobile communications, such as cellular and GSM, may serve as effective substitutes for the wired network, allowing residents and businesses to avoid the delays and unreliability associated with obtaining conventional telephone service. Satellite communications should provide another technological solution, with VSAT networks and teleports becoming increasingly important in economic development. And the convergence of these technologies -- in satellites intended for mobile communications -- should give even the most remote and underdeveloped regions access to sophisticated telecommunications by the turn of the century.

I. INTRODUCTION

It has been nearly ten years since the Maitland Commission released its important report on "The Missing Link."(1) The report emphasized the critical connection between economic development and telecommunications, at the same time noting that "[t]elecommunications have often been neglected in favour of other sectors such as agriculture, water, and roads."(2) During the ensuing period, while there has been increasing recognition of the role of telecommunications in development, the rhetoric has not always been matched by the reality, and the developing world remains woefully underserved by telecommunications.

Among the many reasons for this fact, one key reason is technological. It is simply very expensive, as well as slow and cumbersome, to wire an urban area for telephone service, and then to arrange for a telephone to be installed in each business and home. In rural areas, the situation is even more dismal; "because of the distances involved, the terrain and sparse population,"(3) investments in rural telecommunications often cannot be justified by the returns.

For both urban and rural areas, telecommunications infrastructure development is likely to be dramatically different over the next ten years than it has been during the past decade. The "jumpstart" that will move forward this "engine" of development is technological -- in particular, certain communications satellite and mobile communications technologies that have huge potential for economic development. And the convergence of these technologies -- in satellites intended for mobile communications -- should mean that all parts of the world, even the most remote and underdeveloped, will have access to sophisticated telecommunications within the next several years.

This paper will focus first on terrestrial mobile communications, and on how a combination of technological and regulatory factors has allowed wireless services to supplement (and, in some cases, virtually supplant) the wired network. The paper will next discuss satellite services, including particularly VSAT and teleport options for economic development. Finally, the paper will examine the promise of mobile satellites, and what these yet-to-be-launched "birds" might mean for developing nations.

II. TERRESTRIAL MOBILE COMMUNICATIONS

Ten years ago, cellular telephone service was just getting started in the United States, and the rest of the world had had virtually no experience with mobile telephony. Today, of course, the cellular telephone has become ubiquitous in the United States and in many other countries. In some active financial centers, such as Hong Kong, it seems that virtually every other person on the street is carrying a portable phone. And technologies such as GSM, ESMR, and those associated with personal communications services ("PCS") promise to make terrestrial mobile communications more convenient and more affordable over the next few years.

In developed nations, mobile communications plainly represent a supplement to the ubiquitous wired network. The issue in these countries is not access to telephones per se, but rather (to use AT&T's expression, oft-repeated in the context of its planned McCaw acquisition) access "anytime, anywhere." For a businessperson in Tokyo or Singapore, Honolulu or New York, telephones have become critical to a way of life, and the focus is on being always "in touch."

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In many developing nations, the situation is quite different. In some of these countries, including many of the now-independent states of the former Soviet Union, a person seeking to have a conventional, wired telephone installed may have to wait not merely months, but years. If one wishes to move one's home or office, moreover, the attempt to move the telephone at the same time is likely to be time-consuming and frustrating. Once a telephone is installed, the infrastructure is such that one often encounters busy signals, poor quality, and delays in call completion.

These problems with the wired infrastructure in developing nations are being addressed, but only slowly and at great expense. In many nations, cellular service has proven to be a faster, cheaper way of obtaining, not mobile service, but fixed telephonic communications. In some nations, such as Hungary, cellular service in the cities has become an effective substitute for the wired network, allowing residents to have virtually instant access to telephones that may be moved from home to office and back again.(4)

There can be no doubt that this trend, toward using wireless telephony in lieu of fixed telephony in developing nations, will continue and indeed accelerate. The widespread interest of the global telecommunications giants, including the U.S. Bell companies and several large (non-U.S.) PTTs, in bidding on cellular and GSM franchises in developing nations -- and the high prices that they have paid for such franchises -- provide clear evidence of a key fact: these profit-oriented companies have made a business judgment that there is huge potential in mobile communications for the developing world.

The pace will also be accelerated by the trend toward digital systems, such as those for GSM and ESMR. Another major opportunity will be presented by PCS, a technology just getting under way in the United States.(5) Many of the factors that distinguish PCS from cellular -- such as smaller PCS base stations and lighter, cheaper handsets -- suggest that PCS may be even better suited than cellular to the needs of developing nations.(6)

In summary, mobile communications, principally in the form of cellular services, have already become a force for economic development in nations that lack an adequate wired infrastructure. If regulators in these nations allow more competition among service providers and encourage the introduction of new technologies such as PCS, countries with substandard communications today may quickly find themselves with wireless systems approaching those in the developed world.

III. CONVENTIONAL SATELLITE NETWORKS

Mobile communications have proven to be an effective developmental tool in many countries, but they plainly have limitations; among other things, it is difficult and expensive to extend wireless networks into rural areas, where the sparse population and the absence of business users often mean that construction of base stations simply is not justified. There are also many kinds of non-voice communications, including particularly data and video applications, where terrestrial wireless networks are not a cost-effective solution. In these situations, satellite systems have a critical role to play.

As with mobile communications, a combination of technological, economic, and regulatory factors will conspire to make satellite services increasingly available to the developing world. At one time, not many years ago, satellites' footprints covered principally the major population centers of North America, Western Europe, and Japan. This was true not only for so-called "domestic" satellite systems, but also for "international" systems such as Intelsat's, which (understandably) offered most of its capacity to those nations that were perceived to have most of the demand.

Today, the satellites being built have much wider "footprints," as technology has allowed more powerful beams to focus on a variety of population centers and rural areas. In addition, although satellites and their launches have become increasingly expensive, the demand for satellite services has encouraged both national administrations and entrepreneurs to construct domestic, regional, and international satellite systems. And the increasing deregulation of the satellite industry, modeled on the U.S. "open skies" policies, has allowed a competitive market to develop, to the benefit of developed and developing nations alike.

It is also the case that many of the new satellites planned for the next few years will focus specifically on developing nations. For example, PanAmSat intends to launch Atlantic Ocean and Indian Ocean satellites that will provide significant service to Africa, which a PanAmSat official has called "the most underserved region on the planet."(7) Several satellite companies, including PanAmSat, AsiaSat, and the Asia Pacific Satellite Company, intend to provide coverage of the Indian subcontinent and China, both of which have had relatively little satellite coverage in the past. Russia and the other states of the former Soviet Union, together with the Eastern European countries, represent another focus of satellite planning, particularly as Russia's defense satellite industry converts to civilian uses.

None of this satellite coverage has any meaning, of course, unless facilities are available on the ground. Although there are many possible configurations, two in particular seem to have importance for developing nations: teleports and VSAT networks. In some ways, these two configurations seem to be the opposite of one another, but in fact they may serve complementary purposes in the developmental process.

Teleports represent a centralized focus for telecommunications development within a region. The teleport is a kind of communications hub, a central location from which users can send and receive information via a variety of telecommunications media, including not only satellites, but also fiber and microwave facilities. Teleports typically offer both domestic and international communications, together with flexible network configurations tailored to individual user needs.

Teleports originated in the United States, where they were designed principally as a means of bypassing the wired telephone network. In the developing nations, where teleports are increasingly found, they serve not so much to bypass the wired network as to supplement inadequate facilities.(8) As with terrestrial mobile communications, teleports allow communications users, particularly major ones, to avoid dependence on an unreliable and often expensive local network. Thus, for example, a factory in a developing country, unable or unwilling to rely on the wired network, may send its data communications -- for example, critical orders to suppliers -- via fiber or microwave to a nearby teleport, where these communications can be transmitted, via satellite, to the entire world. It is perhaps no surprise that the principal trade association for teleports is called the "World Teleport Association," or that "the vast majority" of teleports are today "being built outside of the United States."(9)

In some ways, as mentioned above, VSAT networks seem to be the antithesis of teleports; the latter is characterized by centralization, whereas the former involves small "dishes" installed at user premises. In fact, however, VSAT networks typically depend on a central hub earth station, which often may be located at a teleport. And VSAT networks share with teleports the advantage of offering a means to bypass wired telephone networks.

VSAT networks have particular utility in situations where there is a need for information to be distributed on a point-to-multipoint basis, or to be collected on a multipoint-to-point basis, with many of the nodes being located in remote areas. Such situations are often encountered in developing nations; for example, a company operating an oil pipeline through a remote area of South America might use VSATs along the pipeline to monitor flow, weather conditions, and the like, and to open and shut sections of the pipeline as necessary. VSATs are also increasingly important in financial transactions, and in this area their reliability in comparison to the wired network may be critical when a developing nation is seeking to establish, for example, a sound banking system.

In short, both teleports and VSAT networks have important roles to play in telecommunications infrastructure development. These ground-based technologies are only useful, of course, to the extent that there are satellites in space with beams that cover the relevant nations. As more satellites are launched with such beams, we are likely to see increasing use of satellite technology in telecommunications development.

IV. MOBILE SATELLITES

In terms of facilitating development, both mobile communications and satellite communications plainly have roles to play. Satellites cover vast distances and allow users to be effectively independent of the wired network. Mobile services also allow independence from the wired network, but have been limited in their utility by the fact that base stations for mobile communications have relatively narrow ranges. On the horizon (almost literally) is a new technology that will combine the range of satellites with the individualized power of mobile communications: the mobile satellite.

Mobile satellite projects have garnered a substantial amount of attention in the communications community over the past few years. Some of these projects, such as that of American Mobile Satellite Corporation, involve technologies similar to those for existing satellites, in that the satellite itself will be stationary in relation to the earth ("geostationary"). Other proposals, such as Motorola's ambitious Iridium project, are based on a different, somewhat new concept of multiple satellites (66, in Iridium's case) that would be continuously moving in relation to the earth, typically in a low earth orbit ("LEO"). Inmarsat is working on yet another mobile satellite plan, known as "Project 21," that might compete directly with Iridium.

All of these proposals, whether geostationary or LEO, involve at their core the concept of truly ubiquitous mobile communications, in which a user with the appropriate handset could communicate with anyone in the world from any place -- even the most remote places -- in the world. For this reason, mobile satellite systems have significant promise for developing nations, because these systems may offer instant access to worldwide communications networks, with virtually no investment in infrastructure. Although both the hardware and the usage fees associated with mobile satellite services will be expensive, at least at the outset (Iridium is estimating a $3,000 cost for a handset, plus a usage fee of $3 per minute),(10) the fact that there is no other infrastructure required makes these services attractive, particularly in rural areas of developing nations where there may not be any other reliable alternatives.(11)

For the moment, mobile satellite services are just a promise, an interesting source of speculation among communications professionals, but hardly a foundation upon which developing nations may build their communications infrastructures. Nevertheless, these proposals illustrate the tremendous potential of technology to solve the pressing communications development needs of the next decade.

V. CONCLUSION

Advances in mobile communications and satellite technologies should lead to significant opportunities for developing nations to expand and enhance their telecommunications infrastructures over the next few years. By emphasizing some of these newer technologies, developing nations may "jumpstart" the developmental process, obtaining a kind of "instant infrastructure" without having to make massive investments in wired telephone service.

Governments have a key role to play in this process, by establishing policies that encourage private sector investment in new technologies. Experience has shown that, when developing nations open up their cellular licenses to competitive bidding, foreign companies from the developed world are eager to rush in, paying high prices for the right to offer mobile services to the population. Similarly, as nations around the world have begun to deregulate the reception of satellite signals, satellite entrepreneurs have built satellites that have expanded coverage to regions hitherto unserved. With policies that encourage communications competition and foreign investment, a developing nation may find that the populace has telecommunications services readily available, while the government has to invest relatively little of its own scarce funds in the build-out of infrastructure.

The Maitland Commission was clearly correct when it said that "[t]he benefits of the new technology should be fully exploited."(12) We have an opportunity today to exploit a wide range of technologies, including particularly ones for mobile communications and satellite networks. Our success in exploiting these technologies will go a long way toward determining how quickly developing nations are able to expand their telecommunications options in the second decade after the Maitland Commission.

ENDNOTES

1. Report of the Independent Commission for World-wide Telecommunications Development, International Telecommunications Union (Dec. 1984) (hereinafter "Maitland Commission Report").

2. Id., Executive Summary at 4.

3. Id. at 7.

4. In the Republic of Tartar (part of the former Soviet Union), "the region's basic telecommunications infrastructure will be cellular. Phones in homes and businesses will be fixed cellular units." Global Telecom Report, Sept. 20, 1993, at 6, quoting R. Glennon, Alcatel Network Systems.

5. See FCC News Release, "New Personal Communications Services Established," Gen. Docket No. 90-314 (Sept. 23, 1993).

6. One of the other differences between cellular and PCS may also be significant for developing nations. In general, PCS is not thought to be as well-suited as is cellular to vehicular applications, where vehicles are moving quickly among transmitter base stations. This disadvantage of PCS is of less importance to those nations that, lacking an adequate wired infrastructure, may tend to use wireless communications for fixed telephony.

7. Communications Daily, Sept. 17, 1993, at 5, quoting Lourdes Saralegui, Executive Vice President, PanAmSat.

8. According to the President of the World Teleport Association, "the highly advanced infrastructure in America has played against our need for teleports." B. Herr, quoted in Howes, "Teleports," Via Satellite, Aug. 1993, at 30.

9. Id.

10. Communications Daily, Sept. 17, 1993, at 5.

11. The providers of mobile satellite services may also adjust their pricing to accommodate differing needs of developing nations. Iridium, for example, has said that its service might be priced differently "to accommodate less affluent African consumers." Id.

12. Maitland Commission Report at 18.

MAITLAND REVISITED - THE STILL "MISSING LINK"

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Chairman of the ITU High Level Committee (HLC)

1 ABSTRACT

The December 1984 Report, "The Missing Link", of the Maitland Commission has had an important multiplier effect in articulating the inextricable link between telecommunications and development in terms meaningful not only to the converted, i.e. to those actively engaged in the various aspects of communications, but also to those more generally responsible for development planning. Its principal specific recommendation, however, the establishment by the ITU of the Centre for Telecommunications Development (CTD), did not lead to the anticipated mobilization of resources by the private sector. The CTD was wound up by the end of 1991, and its core functions integrated into the ITU's new Telecommunication Development Bureau (BDT), because the CTD had failed to work out a catalytic role, in stimulating telecommunication development, distinct from the Technical Cooperation Department (TCD), the predecessor of the BDT. Enriched by the experence of the recent series of ITU Regional Development Conferences, the ITU World Telecommunication Development Conference (WTDC-94), which will be held in Buenos Aires in March 1994, is a unique opportunity for the wider ITU family - government organizations, private sector entities, regional telecommunication organizations, development and financing agencies - to get its act together in the field of telecommunication development.

2 THE ITU BEFORE MAITLAND

Although the International Telecommunication Union (ITU) is one of the most effective multilateral organizations and has a well-deserved reputation for keeping pace with new technological developments, it has had difficulty in making a real impact in initiatives to close the "telecommunications gap" between developed and developing countries, particularly the Least Developed Countries (LDCs). Frustration over the slowness of demonstrable results in development has manifested itself at successive ITU Plenipotentiary Conferences and, unless a miracle happens at the World Telecommunication Development Conference (WTDC-94) to be held in Buenos Aires in March 1994, the next regular Plenipotentiary Conference, in Kyoto in September 1994, will be no exception.

Since 1949 the ITU has carried out development activities in its dual role as a United Nations specialized agency and as an executing agency for projects funded by the United Nations Development Programme (UNDP) and its predecessors or by funds-in-trust provided by governments or agencies other than the UNDP (1). Until the 1982 Plenipotentiary Conference in Nairobi, when the ITU's development activities were consolidated into the Telecommunication Development Bureau (BDT), it was an uphill battle for developing countries to strengthen the ITU's role as a specialized agency by approving incremental increases in the amount of technical assistance funded out of the ITU regular budget. This trend was opposed by many of the major contributors to the budget, who considered that it would dilute the technical functions of the Union in Radiocommunication and Standardization and, accordingly, should be funded only by voluntary contributions. A small Technical Cooperation Department (TCD) was established in the General Secretariat in the late 1950s and grew in ad hoc fashion until the creation of the BDT in 1989.

3 THE MAITLAND COMMISSION AND THE CENTRE FOR TELECOMMUNICATIONS DEVELOPMENT (CTD)

In Resolution No. 20, the 1982 Nairobi Plenipotentiary Conference "noted with concern that notwithstanding the importance of communications and information transfer dependent on telecommunications infrastructure for social economic and cultural development, a relatively low level of resources has so far been allocated to telecommunications development by international aid and investment organizations". It instructed the ITU Secretary-General and Administrative Council to establish an International Commission for World Wide Telecommunications Development with a mandate, inter alia, "to recommend a range of methods including novel ones for stimulating telecommunication development in the developing world ...", and "to consider the most cost-effective way in which the Union could stimulate and support the range of activities that might be necessary to achieve a more balanced expansion of telecommunication networks".

The Maitland Commission, in its December 1984 report "The Missing Link", declared that, with three-quarters of some 600 million telephones in the world being concentrated in 9 advanced industrialized countries, "the growing imbalance in the distribution of telecommunications throughout the world was not tolerable". It drew four main conclusions. First, higher priority had to be given to investment in telecommunications. Second, the operating efficiency of existing networks in developing countries had to be improved and skills, especially at managerial level, enhanced. Third, financing arrangements had to aknowledge the scarcity of foreign exchange in many developing countries. Fourth, the ITU should play a more effective role.

On the basis of these conclusions, the Commission addressed nearly 30 specific recommendations to governments of both developed and developing countries, to telecommunication operators and equipment manufacturers, to international agencies, and to the Members and Secretary-General of the ITU. The Commission believed that "the range of actions over a wide front, which they had proposed, could achieve the objective the Commission had set of bringing all mankind within easy reach of a telephone by the early part of the twenty-first century" (2).

To strengthen the arrangements through which assistance is provided to developing countries, the Commission recommended the establishment of a CTD composed of a: Development Policy Unit to collect information about telecommunication policies and help developing countries to formulate policies, a Telecommunications Development Service to advise developing countries, at the pre-investment stage, on organization and planning, maintenance, training and personnel policy, procurement policy, tariff policy, integration of telecommunications with general development programmes, financing and investment, etc.; and an Operations Support Group to provide specific assistance such as preparation of plans and specifications for projects.

In July 1985 the ITU Administrative Council established the CTD "within the framework of the Union, and in Geneva....on the basis of voluntary funding and with its own separate and identifiable budget". The CTD's 21-member Advisory Board, which included the ITU Secretary-General as Senior Vice-Chairman, held its inaugural meeting in November 1985. After selection by the Advisory Board, the CTD's Executive Director and Deputy Executive Director started work in September 1986. After the Advisory Board approved an action plan for 1987-1989, the CTD became operational in April 1987. Although the Maitland Commission had estimated that the CTD would require about $10 million U.S. per annum (i.e. the equivalent at the time of 23-25 million Swiss francs), pledged contributions, which were received from 38 countries and 4 global and regional organizations, grew from less than 1.8 million Swiss francs in 1986 to 5.5 million in 1988 and 1989, falling to 5.2 million in 1990 and declining to 3.4 million as of 31 May 1991 (3).

While recognizing that the Advisory Board and CTD staff had done useful work under difficult circumstances, the 1989 Nice Plenipotentiary Conference extended the mandate of the CTD only until the end of 1991, with a further extension subject to a review of its rationale and effectiveness. These reviews were made by the High Level Committee (HLC), outside consultants requested by the Secretary-General to evaluate the CTD (4), and the Advisory Board itself. All recommended that the distinct functions originally envisaged for the CTD should be integrated into the Telecommunication Development Bureau (BDT). The CTD, accordingly, was wound up by the end of 1991.

Why did the CTD not live up to expectations? (5)

- Sir Donald Maitland wanted "a slim, prestigious entity, under the ITU but autonomous, and drawing on the expertise of the private sector" (6). Secretary-General Richard Butler, however, supported by a number of Commission members, wanted to keep the CTD firmly under the ITU. It proved impossible, in practice, to work out a pragmatic middle ground under which the CTD would operate in complementarity with the ITU/TCD-BDT but with a dynamism of its own to harness the expertise and resources of the private sector.

- Not enough attention was paid from the outset to working out a role for the CTD distinct from the TCD. This confusion of roles was compounded by the emphasis of the CTD on operations support rather than policy development and pre-investment advice. The CTD's credibility was not helped by the statement in the Maitland Report "that eventually the CTD and the TCD should be merged". The fate of the CTD was sealed when the BDT was established, since the BDT's mandate was wide enough to cover all CTD and TCD responsibilities and, unlike the BDT, it was not dependent upon voluntary contributions.

4. TELECOMMUNICATION DEVELOPMENT BUREAU (BDT)

At the 1989 Nice Plenipotentiary Conference, Secretary-General Butler, supported by some developing countries, wanted the ITU to approve a number of far-reaching structural changes. The majority of countries, however, including most of the developed countries, did not want to be rushed into making fundamental changes. The compromise was that the immediate decision was taken to upgrade Development to the same level as Radiocommunication (CCIR/IFRB) and Standardization (CCITT) but that further changes would await consideration of the comprehensive analysis and recommendations of "a high-level Committee" that would review the structure and functioning of the ITU.

Article 14 of the Nice Constitution established the Telecommunication Development Bureau (BDT) to replace the TCD. The new Secretary-General, Dr. Pekka Tarjanne, would serve as acting Director of the Bureau until the first Director were elected at the next Plenipotentiary Conference. (In December 1992, Mr. Arnold Ph. Djiwatampu, an Indonesian, was elected as Director). The portion of the ITU budget devoted to Development was increased to 15 million Swiss francs in 1990, rising to 22.5 million in 1994.

In June 1990 the Administrative Council approved the organizational structure for the BDT as proposed by the Secretary-General (7). The BDT is made up of three Departments: Policies, Strategies and Programming; Field Operations; and Programme Support, Organization and Methods. It has Regional and Area Offices in Africa, the Americas, the Asia-Pacific and the Arab States. By the end of 1992 an Advisor for Central and Eastern Europe was added in Geneva to the Field Operations Department.

5. HIGH LEVEL COMMITTEE (HLC)

I had the honour to chair the HLC, which was made up of 21 persons representing a cross-section of ITU Members. The April 1991 HLC Report (TOMORROW'S ITU: The Challenges of Change) contained 96 recommendations for adapting the ITU to meet the challenges of the rapidly changing telecommunication environment.

The HLC considered that the main factors of the changing environment, which will have a continuing impact on the ITU's role, are: globalization; the pace of technological change and of convergence of technologies; the fact that telecommunications underlies the wider information economy and society; the rising importance of regional organizations; the reality that the "development gap" between developing and developed countries will be perpetuated or exacerbated unless the ITU plays a more focused role; and the challenge that, since the ITU family is growing beyond Administrations, Recognized Private Operating Agencies (RPOAs) and Scientific or Industrial Organizations (SIOs) to include users, broadcasters and development and financing agencies, the participation of this wider family in ITU activities should be enhanced.

An analysis of the impact of these factors led the HLC to recommend a better rationalization of the ITU's principal activities into 3 vertical Sectors: Development, Standardization and Radiocommunication. The Development Sector, with World and Regional Development Conferences, a limited number of priority study groups, the Director and the BDT, and a Telecommunication Development Advisory Board (TDAB), would be held responsible for achieving timely results.

This better vertical rationalization would be balanced by improved horizontal integration and management of the ITU across its whole range of activities. This would be facilitated by: the Coordination Committee, chaired by the Secretary-General, working more as a management team; by the 3 vertical Sectors working more collegially with the General Secretariat and with each other; and by the Council focusing more of its attention on broader policy issues, not just on resource questions. The Strategic Policy and Planning Unit, which was recommended by the HLC, has been working collegially, under the Secretary-General, to ensure that major decisions are taken with a better sense of relative priority.

The HLC believed that this greater collegiality across lines within the ITU should be accompanied by increased co-operation outside the ITU with other global and regional organizations. The HLC's first recommendation stated that:

> "... the ITU should play a leading role by working co-operatively, more strategically, and in a more systematic manner, with other intergovernmental organizations, to ensure that, at the international level, a more comprehensive approach is taken to the broader issues of the global information economy and society".

The HLC was careful to say "a", not "the", leading role. The ITU has an important part of the international action but by no means all the action, particularly in Development.

In Chapter V(a), entitled Development - The Still "Missing Link", the HLC was impressed by the fact that multilateral agencies, and the ITU is a relatively small one, can be expected to be the source of only about 5% of the telecommunications investment required in the developing world, with bilateral and commercial arrangements accounting for around 25%, and the lion's share of about 60% having to be generated internally. This does not minimize the importance of the multilateral role, especially for the Least Developed Countries (LDCs). In Recommendation 21, the HLC called for the BDT to give special attention to the requirements of the LDCs. It considered that, if telecommunications is going to be a positive foprce in fostering development rather than having the unintended effect of perpetuating gaps, the ITU would have to sharpen its focus. In Recommendation 4, therefore, the HLC recommended that:

> "... the ITU should play a more clearly-defined catalytic role, as envisaged in Nice Resolution No. 14, by working co-operatively with international, regional and bilateral development and financial agencies, and by presenting to developing countries the range of structural and policy options that will generate greater resources for telecommunications development".

The members of the HLC did not consider that they were in a position to "second-guess" the Secretary-General by commenting on the details of the organizational structure approved by the Council in June 1990. In Recommendation 31, however, the HLC stated that the BDT, working within the Development Sector and collegially with other Sectors of the ITU, should ensure that the ITU's catalytic role in stimulating telecommunication development is strengthened. It went on to warn that:

> "When its performance is judged at future Plenipotentiary Conferences, at Development Conferences, and by the Council, the BDT must be able to demonstrate that it has pursued with dynamism and efficiency the ITU's catalytic functions, such as mobilizing resources and advising developing countries on a range of policies and restructuring models for generating more internal funds for telecommunications development" (8).

All the HLC recommendations requiring amendments to the ITU Constitution and Convention, such as the incorporation of the new concept of the 3 vertical Sectors, were approved in Geneva in December 1992 at the first Additional Plenipotentiary Conference (APP) ever held by the ITU.

6. PROSPECTS FOR A WORLDTEL

The Maitland Commission had recommended that "member states of the ITU, in collaboration with international finance agencies, study the proposals for a revolving fund and for telecommunications investmen trusts as methods for raising funds for investment in telecommunications...", and that "the Secretary-General...study the proposal for an organization to coordinate the development of telecommunications world wide (WORLDTEL)" (9). After an inconclusive discussion at the 1989 Nice Plenipotentiary Conference on the feasibility of a WORLDTEL, the Secretary-General was requested "to follow up its development, without the Union's direct intervention, to take the necessary steps and to act as a catalyst in order to promote the project's development" (10).

The HLC stressed the importance of working to increase the share of funds coming from multilateral sources and of convincing multilateral and bilateral agencies to treat telecommunications as a higher priority. It concluded that: "There does not, however, seem to be enough support at present to convince us that a proposal to establish a new international investment agency devoted to telecommunications development would attract sufficient resources to be viable" (11). Was this conclusion short-sighted?

In 1993 the World Telecommunications Advisory Council (WTAC), established by the Secretary-General following a HLC recommendation, set up a working group to examine the feasibility of establishing a commercially-run world funding and development organization for telecommunications (WORLDTEL). Having reviewed a pre-feasibility study, the working group recommended that a feasibility study be undertaken. In November 1993 WTAC accepted this recommendation and referred it to the Secretary-General for implementation, on the understanding that funds to support the feasibility study would be provided by voluntary contributions.

The viability of a WORLDTEL will depend upon a clear specification of its mission in the light of institutional and market realities. This will answer the question as to whether it is possible, in the real world, for a commercially-run organization to attract sufficient investment capital.

7. WTDC-94

Since the 1989 Nice Plenipotentiary Conference, and leading to the World Telecommunication Development Conference (WTDC-94) to be held in Buenos Aires in March 1994, there has been a full series of Regional Development Conferences (RDCs): for Africa in Harare in December 1990; for Europe in Prague in November 1991; for the Americas in Acapulco in April 1992; for the Arab States in Cairo in October 1992; and for Asia and the Pacific in Singapore in May 1993.

The RDCs set up programmes and follow-up mechanisms in the main areas of activity: telecommunication policies and strategies, financing strategies, human resources development and management' network harmonization, telecommunication indicators, telecommunication development in rural areas, special assistance for the LDCs, frequency management. Imposing burdens have been placed not only on the ITU/BDT and ITU Regional and Area Representatives, but also on the main Regional Telecommunication Organizations. There are legitimate concerns that this may be "more than the traffic can bear".

WTDC-94 is the appropriate time, having absorbed the lessons of recent experience, to approve a strategic framework to guide the activities of the wider ITU family in the crucial field of development. The Action Plan to be approved in Buenos Aires, and the parallel work programme for the BDT, must adapt the ITU's role to the realities of a rapidly changing environment, limited resources chasing pressing needs, and high expectations. Everyone agrees that the ITU must play a "catalytic" role. WTDC-94 should decide what this means in practice and how the ITU should share the load with the wider ITU family.

If WTDC-94 is judged a success, the ITU's strategy and programme for Development can be reaffirmed at the Plenipotentiary Conference in Kyoto in September 1994. If this opportunity is lost, however, more articles will continue to be written concerning: The Still "Missing" Link.

8. REFERENCES

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(2) Sir Donald Maitland The Missing Link Revisited. APT Journal May 1993; and A Decade After the Missing Link, Second INMARSAT International Conference on Mobile Satellite Communications, Paris, 12-14 October1993.

(3) Dr. E. Becher: The CTD - Vision and Reality, final issue of CTD Newsletter, September 1991.

(4) Booz, Allen & Hamilton: Evaluation of the CTD, 18 January 1991.

(5) See references cited in (3) and (4) for useful objective assessments.

(6) First reference cited under (2).

(7) Second reference cited under (1).

(8) HLC Report, Chapter V(a), para. 4.6., page 27.

(9) Maitland Report, Chapter 10, para. 10 h) and i), page 68.

(10) Nice Plenipotentiary Document 522 (Summary Record).

(11) HLC Report, Chapter V(a), para. 1.5, page 23.

CHILE A WINDOW TO THE PACIFIC

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It is a great privilege to participate at the PTC'94 seminar and to be among so many distinguished representatives of this vast and increasingly important part of the world, the Pacific.

Chile, a Pacific nation by virtue of geography commercial, political and historical reasons occupies some 4400 km of coast line in the south eastern quadrant of the Pacific rim. Its 13,2 million inhabitants are mainly distributed over the 741.000 sq km. of continental Chile.

The northern part of Chile, where 10% of the population lives has dessert climate and represents 41% of the total continental surface area. The central zone, represents 29% of the continental surface area and accommodates more than 88% of the Chilean population. The southern zone representing 30% of the surface area, has only 1.5% of its population.

The Antarctic Territory, consisting of some 1.500.000 sq km and the offshore possession of Eastern Island 3800 km west into the Pacific have consistently drawn the attention of writers explorers and conservationist world wide.

This unusual distribution product of a wild and sometimes referred as a crazy geography has shaped not only the nature of its population but, it has acted as a crucial motivator in shaping the demand for a modern and efficient telecommunications network infrastructure.

Chilean independence at the beginning of last century prompted the commencement of international trade and the commercial development of its natural agricultural and mining markets. This aspect, compounded with the favourable geographical location in the midst of the shipping routes to the north pacific, made it essential, to introduce appropriate communications facilities.

In 1851, Guillermo Wheelwright an american engineer living in Chile built and inaugurated the first railway line in South America and introduced the concept of telegraphy.

From a different latitude, history sadly reminds us of the assassination of Abraham Lincoln in 1865 the news reached England three months later by sea.

As we understand, it was the last out of date news as in 1866, the first submarine telegraphic cable was inaugurated initiating as such, the commencement of near real time universal communications.

In Chile, only 8 years later in 1874, the first steps towards the implementation of a submarine telegraphic cable network were performed. This major achievement permitted in 1875 to receive the news of Bell's remarkable invention almost immediately.

Five years later, in 1880 the first concession for telephone services was granted by the government to the "Compañia de Telefonos de Edison" to operate a local network in the city and main port of Valparaiso.

By 1881, there were some 200 to 300 telephones in operation and the scenario was set for the implementation of independent local networks throughout the main cities along the country.

This humble beginnings, lead the way to the creation of "Compañia de Telefonos de Chile" today, the country's main service provider and responsible for the development of the network infrastructure required in today's demanding and competitive environment.

Ten years have gone past since the publication of the report of the independent commission for worldwide Telecommunications developments.

It is my great pleasure indeed, to review the progress made in Chile in the telecommunications sector during this past decade referred by many, as the transitional period between the standardized assembly line economy and the information or software customized economy.

As we all know, The Maitland report well defined and characterized the prevailing scenario in 1984 through the adoption of the statement, "The missing link".

Today, though many changes have taken place it is still valid to say that the current telephone densities throughout the developing world are far from the objectives identified by the commission.

In 1959, the United States alone, had 50% of the phones of the world, today, that figure has been reduced to some 30% in a geographical area representing only 4% of the world's total population.

Pitroda, from the World Telecommunications Advisory Council somehow depicts this scenario, in the well known statement "Islands of affluence and desserts of poverty".

Latinamerica, with a population of 443 million people distributed over 46 countries in the Caribbean, Central and South America is no exception to the Island concept.

This new approach, required changes in the organizational structure to implement, a more dynamic, responsive and accountable enterprise. For this purpose, a geographically decentralized structure was adopted with full accountability for the implementation of the necessary installation program required to satisfy that area's, basic telephone demand.

Also, subsidiaries representing distinctive business areas such as Cellular, Long Distance National and International, Corporate Customers and Terminal Equipment were created in order to enter and successfully compete in this highly dynamic business sector.

The results achieved and in essence, the objective of this paper follow. Compañia de Telefonos de Chile (CTC) is the Largest Telecommunications Company in Chile, with concessions that permit the operation of basic telephone services throughout the entire country, except two regions in the south covering 77% of the surface area and 92% of the entire population representing as such, 94% of the market segment.

The revenue achieved during 1992 represents a 20.2% increase on 1991 and were derived 75% from regulated services and 25% from non regulated areas. As a point of comparison, we can see the situation in 1987 and projection to 1997. Local Telephony within the regulated areas, is the major revenue generator representing 51.7%.

In this market segment although CTC's large participation there are another two companies providing local services in competition with CTC in the same service area, and two in the south where CTC has no concession.

In the long distance segment, CTC through Government Decree N°202 of the 15th of October 1982 is entitled to provide services in the long distance national and international market segments throughout the use of its own or leased facilities. Currently, the Telecommunications Law is under review to include the participation of local companies in the long service market through the implementation of a dial up multicarrier access system.

The past decade for CTC, has been represented by a remarkable growth not only in basic telephony but in the number of new services created under an open and competitive scenario.

Since the Maitland recommendations in 1984, CTC has increased three fold the number of lines in service and more than doubled the telephone density maintaining each and every one of its staff to reach today 152 lines per employee from a low of 70, 10 years ago.

This figure, compares still somehow low with the 208 lines per employee for Asia Pacific OECD countries, but very favourably with the Asia Pacific average of 67.

The performance of the network and service quality, are two aspects that reflect the huge technical and financial effort put toward the complete digitalization of the network. In 1992, CTC installed 230.000 lines achieved, 76% digitalization.

The 1993-1998 development plan, contemplates for 1993, the installation of 600.000 digital lines (includes replacement of analogical lines). This remarkable milestone represents 1.3 equivalent CTC's of 1984. In other words, what took 104 years to achieve, was done in less than 12 months completing as such, the much desired full digitalization of the network.

The pictorial representation clearly identifies the pre and post privatization averages where, a gain factor of 6.6 differentiates the later.

The financing of this huge infrastructure development, represents the largest project ever undertaken by the private investor in Chile. In fact, the projected expenditure to 1998 since privatization in 1987 is of the order of 3.2 billion dollars. That is, an average annual investments post privatization to 1993, of some US $ 322 million dollars.

Funding CTC's development program has been achieved through a combination of sources. For example, during the period 1988 to 1992, 38% of the requirements were internally generated through the retention of operational revenues, 18% through capital increase, 21% through local financing and the remaining 23% through overseas borrowing.

The upgrade of Chile's borrowing risk standard to a BBB'i rating by Standard & Poors, has paved the way for CTC to achieve investment grade status and consequently, assisting in the obtention of lower international credit costs.

The BBB investment grade obtained, puts Chile at the top of other Latinamerican countries ahead of Mexico, Brazil and Argentina becoming as such, the lesser risky country in the region.

What is ahead of us, in the next 10 year period is tremendously challenging and personally satisfying as competition will continue to prevail, pressing for new services and forms to satisfy the customers changing needs.

The decade of customized solutions is about to begin and, the telecommunications industry being no different to other services industry will aim more and more to the personal satisfaction of the individual. We at CTC, with the customer in mind and the corporate commitment of satisfying the pending applications by 1998, have developed the 1993-1998 corporate plan to include the installation of 800.000 lines within the S year period.

Today, the first year of this ambitious program has been completed and a total of 270.000 new lines are available to our customers. The achievement of this milestone is of significant importance as we reach a teledensity of 11.6 lines in service per 100 inhabitants becoming as such, part of the medium teledensity countries.

For this group, the line of best fit follows a linear relationship where, an increase of 1000 dollars per capita in the GDP, is equivalent to an increase of 3.26 lines per 100 inhabitants.

Telephone densities vary from a low of 0.7 in Haiti to a high of 66 in Bermuda with an average of 7.3 per 100 population. This compares slightly below, the world's average of 9.77 recorded on the 1st of January 1992.

The reasons for this sad differences between those countries that have and those that don't is beyond the scope of this paper however, it is my belief that the right scenario is shaping up, for a more significant development of the basic telephone infrastructure.

On the one hand, the developing world is waking up to the reality that there is a close association between Gross Domestic Product (GDP) and telephone density and on the other, the developed world by the way it forges ahead with strategic alliances, free trade zones and global projects, that require the implementation of large regional networks is acting, as subtle pressure points and catalysers for governments to consider, the various options available today to finance the development of their local infrastructure.

In 1985, it was estimated that Latinamerica alone, (OAS countries) required between $70,000 to $130,000 million dollars to the year 2000 in order to maintain a constant telephone density.

To increase and modernize the existing networks the investment required are much larger.

It is estimated, that some 60% of past expenditure was financed through local means specifically via tariff increase, 25% by the equipment supplier through the use of banks, commercial agreements and bilateral assistance schemes. And, another 5 to 10% through the use of multilateral organizations and only, the remaining 5% by the private investor.

It is my belief that today's Latinamerica is offering a stronger platform for the private investor to play a more dominant role in the development of its telecommunications infrastructure.

We have learned, about the cases in Mexico, Argentina, Venezuela and Chile. We have yet to see how this open market approach takes up in Peru, Bolivia, Colombia and Ecuador and eventually in all Central America as well.

Today's private investors when confronted with Latinamerican issues, are more inclined to think in terms of hope rather than fright as the scary predictions of the 80's have failed to materialize and economic reform sweeps through the old protectionistic attitude.

The question today is not about believing in the free market approach, but how to manage the free market environment. The great majority of Latinamerican countries are experiencing real economic growth are controlling inflation and successfully restructuring their foreign debt.

CHILE, a successful model where foreign investment grows at 15% per year, production has diversified from products in 1984 to items in 1993 and its exports represent 30% of its production, was one of the principal motivators for this open market approach.

Today, Chile, is not only providing consultants to counsel other Latinamerican governments in a large range of economic and privatization issues but is also investing in this emerging markets competing face to face with large international organizations.

This successful development, has been a combination of many factors however, the privatization of the telecommunication sector has played a fundamental role in terms of developing this market segment essential in today's competitive and diversified business scenario.

The predominant situation in Chile, in the 1980's prior to the privatization of the telecommunications sector was characterized by a large deficit of telephone lines represented by some 300.000 lines of unsatisfied demand.

This deficit, had been accumulated throughout the years as a result of the lower priority assigned by the government in relation to other areas. Specifically, commitments in the social area.

In 1985, investments needs in basic public telephony alone was estimated to be of the order of 1.100 million dollars for a 10 year development plan considering the installation of 630.000 phones.

It was obvious that the solution to this problem, was to consider the alternative of private investment as a means of generating the much required capital infrastructure. On this basis, the government decided to review its regulating role and adopted a policy recognizing the market to be an efficient assigner of financial resources.

In 1987, modifications to the 1982 telecommunications law were promulgated setting as such, the preliminary framework for the privatization process that followed.

In summary, this framework established a two year period as the maximum time that a service provider had, to provide service within its concession area.

In order to finance the investment, the service provider was allowed to charge an additional sum reimbursable through the issue of ordinary shares. This mechanism was in essence, a disguised form of privatization.

The principal modification established to the law, was with no doubt, the introduction of a new tariff framework where all basic telephone services not subject to competition as defined by the Antitrust Commission were to be, regulated by the authority.

This framework, established a 5 year period for the calculation of the relevant tariff based on indexation formulas and the concept of cost based services.

The privatization of CTC in Chile, in addition to injecting the much required resources, it also triggered a series of changes that are today reflected in the excellent operational results achieved.

Specifically, a new corporate identity was adopted where the concepts of customer orientation, bottom line results and competitive scenario were highlighted.

The threshold between medium and high teledensity countries has been set at 20 lines per 100 inhabitants by the latest ITU report (May 1993). We are confident at CTC that we are heading towards that target, as by 1998 a total of 13 lines in service per 100 inhabitants will be achieved.

Complementing this challenging development program, CTC will continue to develop its intelligent network infrastructure and integrated services digital network to promote and expand in a variety of services including personal and universal numbers, virtual private networks, information services, videotext, virtual telephone and the expansion of the services areas of its dedicated digital network and cellular networks.

The rural sector is somehow more complex and expensive to satisfy and as such, requires the coordinated effort of the service provider and government, in order to optimize the planning of a suitable solution.

Studies performed by CTC have identified some 2567 rural localities of less than 3000 people without telephone facilities. Evaluation of possible alternatives include solutions based on cellular telephony, digital and analog multiaccess systems, VHF and UHF single channel systems and others.

The task ahead is by no means trivial and the proposed program contemplates the installation of facilities to a maximum of 200 localities per year with government subsidy varying in function of the population in the community.

The estimated total investment to satisfy the rural program is of the order of US$ 52 million dollars with an average investment program of us $ 20.000 per installation. Public telephony on the other hand, has gone through a major installation program during the 10 year study period. In 1984, the total number of public phones totalled only 8.283 representing 0,7 telephones per 1000 inhabitants. In 1993, this figure has increased to 1,6 per 1000 inhabitants with a total of 20.815 public phones installed. The remaining of the 19931998 plan includes an additional 14.500 phones to increase the final public phone density to 2,2 per 1000 inhabitants.

Ladies and Gentleman, may I conclude by saying that the last decade has witnessed in Chile, one of the most remarkable achievements ever performed by private investment in the development of a modern and efficient network infrastructure. We are conscious that success in the past does not necessarily guarantee success in the future and, on that basis, CTC is developing the necessary strategies to make sure that all the necessary steps are considered to continue developing the network infrastructure, in accordance with the requirements of a modern and demanding corporate community and, to provide the most modern and up to date telecommunications services comparable to the best in the world.

From a regional perspective, Latinamerica still has a long way to go as poverty conditions still prevail over a large portion of the community and, the necessary telecommunications infrastructure is far from reaching the appropriate teledensities required to support today's highly sophisticated business markets.

However, I am confident, that the process of change already underway in most of Latinamerica, will continue in its efforts to liberalize and establish the grounds for a free market scenario conducent to a larger private investment program.

NETWORK PLANNING: A MUST TO CLOSE THE MISSING LINK THE VENEZUELAN EXPERIENCE

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ABSTRACT

The Missing Link, as figuratively defined by the Maitland Commission in late 1984, is the still widening gap between the number of telephones in facilitated countries and telephones in developing countries.

The political will to prioritize telecommunications and the wise management of scarce financial resources are firsts, among other requirements, for development of telecommunications in under- facilitaded countries.

In Venezuela, prioritization of telecommunications services in 1992 led to the privatization of the National Telephone Company C.A.N.T.V. from government ownership to private capital majority ownership. This move provided the resources to increase investment in telecommunications and begin to organize the operating company along the lines of a commercial entity.

Two major actions were then initiated and continue to evolve in a balanced manner: the provision of service towards clearing the subscriber waiting list, and a program of improvement of the network operating efficiency and of the optimization of its present configuration and future expansion.

Concurrently, a thorough review and modernization of the planning process for network technical and cost optimization was undertaken.

This paper reports on the benefits of optimized network planning and the computerized planning methodology employed.

1

BENEFITS OF OPTIMIZED NETWORK PLANNING

Network planning in developing countries, designed to optimize technically and economically the conversion of existing telephone networks from analog to digital technology and the planning of new digital voice and data networks, will bring about financial, operational, customer relations and economic benefits.

Financial benefits derive from optimized routing and switching which reduce the cost of network conversion and expansion, and increase the number of subscriber connections. Operational benefits derive from improved network performance and grade of service. Customer relations benefits result from augmented subscriber connections and concurrent service improvement which better satisfy the users' compelling needs. Economic benefits are realized by the efficient utilization of the telecommunications infrastructure, basic for national economic growth.

Regardless of the degree of network sophistication, the use of a computer for network planning is required by the huge quantity of data to be manipulated and the complex computational formulae utilized. Computer technology for telecom networks has evolved from the early awkward use of large mainframes and minicomputers, to the modern simple use of microcomputers (PC's), utilizing universally known programming languages, generally driven by a menu.

PLANNING METHODOLOGIES

Because of the universal objective of satisfying users' demand efficiently, with good quality and at affordable prices, network planning is just as important for mature and modern networks as it is for less advanced networks. However, the planning methodologies are somewhat different for the two situations.

There are two different philosophies to network planning. One (theoretical) is centered on mathematical modeling and achieves a single solution, optimal in theory if all input data is complete and reliable and if the model reflects the network behavior. The other (practical) is based on a heuristic approach, requiring the active participation of the planner to prescribe as many network configurations as desired and then to select the most convenient one, after computer evaluation. In this case, the input data need not be totally accurate or even complete, as the computer programs themselves devolop the matrices of traffic based on methodologies such as the CCITT-adopted "community of interest factor" relationship between any two exchanges in the network and the Kruitoff algorithm.

For rapidly growing and overloaded networks, where existing point-to-point traffic data is scanty or inaccurate (often the case in developing countries), the heuristic approach to network planning is more effective.

2

Over the past few years, both planning methodologies have been tested at C.A.N.T.V., the mathematical one embodied in the PLANITU sofware, and the heuristic one embodied in the NETPLAN software. NETPLAN was adopted by C.A.N.T.V. for planning and optimizing the national interconnection network.

The specifications of the NETPLAN software are included in Appendix A.

C.A.N.T.V. NETWORK PLANNING & OPTIMIZATION

The NETPLAN software operation, as applied to the optimization of the C.A.T.V. network, is depicted in figures 1 to 14, which indicate the input data and the output data for the sequential parts of computation.

All programs have been adapted to the C.A.N.T.V. network profile, have been istalled and fully tested both in the source code and in the executive language. Training of the C.A.N.T.V. planners on the use of the software has been completed. National network planning and optimization has recently begun.

In lieu of reporting on actual comparison of C.A.N.T.V. network alternative configurations, which are not yet available, typical examples including SDH/SONET configurations are shown in a number of slides and are discussed during the presentation.

Similar behavior is expected from the Venezuelan experience.

CONCLUSION

Suitable computerized network planning and optimization can and does bring about significant operational, financial, economic and social benefits. Indeed, it is - among others- one necessary requirement to bridge the "Missing Link".

3

APPENDIX A

NETPLAN SPECIFICATIONS

(A) -NETPLAN SOFTWARE OVERVIEW-

The NETPLAN software designs and optimizes the structure of a digital network, including the progressive conversion of the existing analog portion to digital. It evaluates and derives, for each network configuration prescribed and for each year selected, parameters such as:

- Point-to-point traffic matrices.
- Optimized distribution of tandem and transit traffic.
- Optimal quantity of direct and transit trunks and their routing.

- Overall efficiency of the trunking network.
- Network flexibility.
- Elimination, or avoidance, of congestion.
- Cost of the network, existing and additional investment required.
- Corresponding present worth of annual charge.

The NETPLAN software optimizes the switching and transmission portions of the system, resulting in network flexibility, traffic flow efficiency and robustness of non-hierarchic routing.

The NETPLAN computer programs rest on the following technical prescriptions:

1) priority of digitalization of tandem and transit exchanges over digitalization of terminal exchanges.

2) interconnection of tandem, or transit,

exchanges via a high velocity digital transmission ring.

NETPLAN is a set of programs written in Fortran and driven by a menu. It is easy to learn and easy to run. Experience in several countries shows that 15 days are sufficient to learn how to prepare input data and how to run the programs. The programs run in a dos-compatible personal computer with co-processor and 60 Megabit free in the hard drive, to accomodate planning of metropolitan network encompassing several million lines and long-distance networks with hundreds of area codes.

(B) -NETPLAN SOFTWARE SPECIFICATIONS-

1. The software is used to plan and achieve technical and economic optimization of analog voice and data networks undergoing conversion to digital, as well as of analog or fully digital networks.

2. The software includes programs and subroutines for the optimization of at least the following voice and data networks:

   -Metropolitan
   -Long Distance
   -Regional
   -International
   -Cellular (switching optimization)
   -Satellite
   -Rural
   -Private
   -Plesiochronous (PDH)
   -Synchronous (SDH and SONET)
   -Introduction of CCITT #7 signaling

3. The programs and subroutines are written in commonly used languages, for use with personal computers.

4. The software is supplied in executive language and can be supplied also in the fortran source code with comments explaining each group of instructions. Training is provided in the use of the software as well as in programming.

5. The software is designed to be adaptated and fine tuned to the unique network profile in terms of technical standards, numbering plan, any type of equipment, and other technical network characteristics.

6. The traffic calculations are formulated and programmed making use of the "Community of Interest Factors" defined by the CCITT as the basis for the forecast of future traffic, further modified with the Kruitof algorithm.

7. The computation of trunk quantity and trunk groups, based on the matrices of traffic and extended to all exchange units and also including computation of high-usage trunking via calculation of the economic erlang and of peakdeness factors, can be executed with a choice of different algorithms to be selected by the planning engineer.

8. For long-distance networks, the software is designed for the interface between different services in a mesh adopting a unique national numbering plan.

9. The software can elaborate as many alternatives of network configurations as desired by the planner, indicating the relative costs and technical parameters, so that a judicious choice among the alternatives can be made.

10. The software does perform sensitivity analyses of events and conditions inputted by the planner, showing in each case the technical and economic consequences of the event considered.

11. Updates, modifications, changes and other variances can be easily inputted and overall network results quickly assessed.

12. The software has the capability of showing a graphic presentation of the network alternatives and corresponding configurations.

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NOTE: THE NETPLAN SOFTWARE IS COPYWRITED BY THE U.S. LIBRARY OF CONGRESS, TXU 511 685, JANUARY 7, 1992.

NETPLAN

NETPLAN IS A SET OF SEQUENCED COMPUTER PROGRAMS FOR PLANNING AND OPTIMIZING TELECOMMUNICATIONS NETWORKS.

NETPLAN IS BASED ON A HEURISTIC APPROACH AND IS DESIGNED FOR A COMPARATIVE ANALYSIS OF ALTERNATE NETWORK CONFIGURATIONS AT SEVERAL POINTS IN TIME (PHASES).

IN ITS APPLICATION FOR C.A.N.T.V., NETPLAN INCLUDES 146 COMPUTER PROGRAMS WITH OVER 45,000 LINES OF INSTRUCTIONS, ADAPTED TO THE TELECOMMUNICATIONS ENVIRONMENT AND STANDARDS OF VENEZUELA, FOR THE OPTIMIZATION OF C.A.N.T.V.'s:

- METROPOLITAN NETWORKS
- PRIMARY LONG-DISTANCE NETWORK
- REGIONAL LONG-DISTANCE NETWORKS
- INTERNATIONAL NETWORK
- SDH/SONET NETWORKS

FIG. 1

NETPLAN

FOR EACH OF THE METROPOLITAN AND LONG-DISTANCE NETWORKS, NETPLAN COMPUTATION IS DIVIDED IN SIX PARTS:

PART ONE = PREPARATION OF A DATA BASE INCLUDING TRAFFIC, EXCHANGES, AND THEIR CHARACTERISTICS.

PART TWO = ESTABLISHMENT OF ALTERNATE NETWORK SWITCHING CONFIGURATIONS, ALTERNATE TRANSMISSION MEDIA AND CRITERIA FOR TRUNK CALCULATION.

PART THREE= DERIVATION OF THE TRUNK MATRIX, OF NETWORK TECHNICAL PARAMETRS, OF EXISTING AND FUTURE NETWORK INVESTMENTS AND OF THE PRESENT WORTH OF ANNUAL CHARGES.

PART FOUR = COMPARATIVE ANALYSIS OF NETWORK ALTERNATIVES.

PART FIVE = REPORT PRINTING.

PART SIX = GRAPHIC REPRESENTATION OF NETWORK ALTERNATIVES.

FOR EACH ALTERNATIVE, FOR EACH PHASE, AND FOR EACH OF THE SIX PARTS, THE COMPUTING SEQUENCE GOES FROM INPUT DATA TO DATA PROCESSING TO OUTPUT DATA.

FIG. 2

NETPLAN

FOR INTERNATIONAL NETWORKS, NETPLAN COMPUTATION FORECASTS TRUNK REQUIREMENTS ON THE BASIS OF PRESENT INTERNATIONAL TRAFFIC AND SELECTION OF INTERNATIONAL TRANSIT ROUTES.

FOR EACH ALTERNATIVE AND FOR EACH PHASE, THE SOFTWARE COMPUTES THE TRAFFIC LEVELS ECONOMICALLY CONVENIENT TO ESTABLISH NEW TRAFFIC ROUTES OR TO INCREASE THE QUANTITY OF DIRECT CIRCUITS WITH TARGET COUNTRIES.

INPUT DATA ARE: THE VALUE OF THE ECONOMIC ERLANG SELECTED, THE LIST OF POTENTIAL TRANSIT COUNTRIES AND THE TRANSIT COST (PAID MINUTE).

FOR EACH ALTERNATIVE AND FOR EACH PHASE, THE SOFTWARE COMPUTES THE MOST ECONOMIC BALANCE BETWEEN DIRECT TRAFFIC AND TRANSIT TRAFFIC, AND THE OVERALL ANNUAL COST OF INTERNATIONAL CIRCUITS.

FIG. 3

NETPLAN

FOR SDH/SONET NETWORKS, NETPLAN COMPUTES SYNCHRONOUS RINGS ALTERNATIVES AFTER SELECTION OF THE MOST CONVENIENT METROPOLITAN, LONG-DISTANCE OR REGIONAL SOLUTION AS A RESULT OF NETPLAN SOFTWARE NETWORK OPTIMIZATION.

FOR EACH SDH/SONET ALTERNATIVE AND FOR EACH PHASE, THREE DIFFERENT CASES ARE ANALYZED:

- *THE SHORTEST TRUNK GROUP ROUTE (NO PROTECTION)
- *FULL PROTECTION (1+1) ON BOTH SIDES OF THE RING (LINE SWITCHING)
- *ONE HALF OF THE CIRCUITS ON ONE SIDE OF THE RING AND THE SECOND HALF OF THE CIRCUITS ON THE OTHER SIDE OF THE RING (PATH SWITCHING)

FOR EACH SDH/SONET ALTERNATIVE, FOR EACH PHASE, AND FOR EACH OF THE THREE CASES ABOVE, NETPLAN COMPUTES:

- -THE QUANTITY OF 2MB/S GROUPS IN EACH LINK OF THE RING AND IN THE SPURS
- -THE REQUIRED FIBER QUANTITY
- -THE DROP/INSERT MULTIPLEX REQUIREMENTS
- -THE OVERALL TRANSMISSION INVESTMENT
- -THE ECONOMIC COMPARISON USING PLESIOCHRONOUS TRANSMISSION,

AND PERFORMS A SENSITIVITY ANALYSIS SIMULATING ANY RING INTERRUPTION.

FIG.4

NETPLAN

PART ONE

INPUT	DATA PROCESSING	OUTPUT
LIST OF ECHANGES		COMMUNITY OF INTEREST FACTORS MATRIX
EXHANGE COORDINATES	PROGRAMS	
ACTIVE LINES	UTILIZING COMMUNITY OF INTEREST FACTORS	RELIABLE TRAFFIC MATRIX EXHANGE TO EXCHANGE
TRAFFIC MATRIX (IF RELIABLE)	AND	
OR	ALGORITHM OF KRUITOFF	LIST OF INPUT DATA ERRORS
AVERAGE COMPLETED TRAFFIC PER SUBSCRIBER FOR EACH EXCHANGE		
SUBSCRIBER CATEGORY (IN PERCENTAGE)		
COMMUNITY OF INTEREST FACTORS BETWEEN AREAS		

FIG.5

CC2

NETPLAN

PART ONE

FOR EACH OF THE THREE PHASES

INPUT	DATA PROCESSING	OUTPUT
EXCHANGE UNITS		
ACTIVE LINES FOR EACH UNIT AND FOR EACH PHASE	PROGRAMS UTILIZING	RELIABLE POINT TO POINT TRAFFIC MATRIX OF EACH EXCHANGE UNIT WITH ALL OTHER EXCHANGE UNITS IN THE NETWORK
OTHER FACTORS	COMMUNITY OF INTEREST FACTORS MATRIX	FOR EACH OF THE THREE PHASES
CHARACTERISTICS AND TYPE OF EACH EXCHANGE UNIT	AND	
TIME VARIATION FACTORS AND COEFFICIENTS	ALGORITHM OF KRUITOFF	THE THREE PHASES MAY COVER ANY PERIOD FROM 1 TO 15 YEARS

FIG.6

NETPLAN

PART TWO

FOR EACH PHASE AND
FOR EACH ALTERNATIVE

INPUT	DATA PROCESSING	OUTPUT
PARAMETERS:		
TITLE OF ALTERNATIVE		
LIST OF POSSIBLE TRANSIT EXCHANGES EXISTING AND PLANNED		FOR EACH PHASE AND FOR EACH ALTERNATIVE: A NEW EXCHANGE-UNIT LIST
OVERFLOW TRAFFIC ROUTING	PROGRAMS	
•FIRST SELECTION •SECOND SELECTION	INSERTING PARAMETERS INTO PART ONE DATA	A POINT TO POINT NEW TRAFFIC MATRIX
CHOICE FOR:		
LONG-DISTANCE ACCESS INTERNATIONAL ACCESS SPECIAL SERVICES ACCESS		LIST OF INPUT DATA ERRORS

FIG.7

CC3

NETPLAN

PART THREE

FOR EACH PHASE AND
FOR EACH ALTERNATIVE

INPUT	DATA PROCESSING	OUTPUT
PARAMETERS:	PROGRAMS	
HIGH AND LOW LIMITS FOR HIGH-USAGE FORMULAS	FOR THE COMPUTATION OF OVERFLOW AND HIGH-USAGE TRUNKS VIA FIVE ITERATIONS FOR ONE-WAY AND TWO-WAY TRUNKS	TRUNK MATRICES
AVERAGE COST OF A/D CONVERSION		ROUTING ALTERNATIVES (TRUNKS, TRAFFIC, MEDIA)
TRANSIT SWITCHING COST		FOR EACH EXCHANGE UNIT
TYPE OF EACH EXCHANGE UNIT	SUBROUTINES	
PRESCRIBED GRADE OF SERVICE	FOR COMPUTATION OF THE ECONOMIC ERLANG (ANALOG OR DIGITAL)	AND FOR -ANALOG ROUTES -DIGITAL ROUTES -ANA/DIG ROUTES

FIG.8

NETPLAN

PART THREE

FOR EACH PHASE AND
FOR EACH ALTERNATIVE

- THE OPTIMIZATION OF TRANSIT TRUNKING MUST BE IN ACCORDANCE WITH THE CHARACTERISTICS OF EXCHANGE EQUIPMENT AND TRANSMISSION MEDIA, ALONG THE FOLLOWING GENERAL CRITERIA:

  * PERUSING ANALOG EQUIPMENT TO ITS ECONOMIC LIFE
  * AVOIDING FURTHER PURCHASE OF ANALOG EQUIPMENT
  * MINIMIZING THE PURCHASE OF A/D CONVERTERTS

- CONSIDERATION OF THE TRAFFIC PEAK FACTOR IS ESSENTIAL IN THE COMPUTATION OF HIGH-USAGE FORMULAS AND IN THE EVALUATION OF THE ECONOMIC ERLANG

FOR THE COMPUTATION OF DIRECT TRUNKS, SEVERAL ALGORITHMS ARE AVAILABLE FOR SELECTION BY THE PLANNER:

* ERLANG B
* MODIFIED ERLANG B
* WILKINSON 2'
* GRADING AND "E" FACTOR
* ANY OTHER CHOSEN ALGORITHM, INTRODUCED VIA NEW SUBROUTINES

FIG.9

NETPLAN

PART THREE

FOR EACH PHASE AND
FOR EACH ALTERNATIVE

INPUT	DATA PROCESSING	OUTPUT
TRUNK MATRICES		SUMMARY TABLES:
DETAILED COST: * ANALOG MICROWAVE -HIGH CAPACITY -LOW CAPACITY * DIGITAL MICROWAVE -HIGH CAPACITY -LOW CAPACITY * OPTICAL FIBER * PHYSICAL CABLE	COMPUTATION PROGRAMS	* TRUNKS * TRAFFIC * EFFICIENCY * TRANSIT EXCHANGE UNIT TERMINATIONS * A/D CONVERTERS * CIRCUIT-KM ALL SUBDIVIDED IN: - ANALOG - DIGITAL - COMPOSITE - INVESTMENT IN NEW EQUIPMENT ONLY - INVESTMENT IN EXISTING AND NEW EQUIPMENT - PRESENT WORTH OF ANNUAL CHARGES
DISTANCE TABLES FOR EXISTING AND PLANNED TRANSMISSION MEDIA		

FIG.10

NETPLAN

PART FOUR

COMPARISON OF ALTERNATIVES

INPUT	DATA PROCESSING	OUTPUT
DISKETTES WITH SUMMARIES FOR EACH ALTERNATIVE	PRINTING & GRAPHIC PROGRAMS	12 COMPARATIVE LISTS AND DIAGRAMS INCLUDING: *TRUNKS *TRAFFIC *EFFICIENCY *FLEXIBILITY *CIRCUIT-KM *INVESTMENT IN -NEW EQUIPMENT ONLY -EXISTING AND NEW EQUIPMENT -TRANSIT SWITCHING -TRANSMISSION MEDIA *P.W.A.C.

FIG.11

NETPLAN

PART FIVE

REPORT PRINTING

INPUT	DATA PROCESSING	OUTPUT
DISKETTES WITH SUMMARIES FOR EACH ALTERNATIVE OTHER LISTS AND REPORTS PREPARED WHEN RUNNING PARTS ONE AND THREE	PRINTING PROGRAMS	* LIST OF EXCHANGE UNITS FOR EACH PHASE * POINT TO POINT TRAFFIC MATRIX FOR EACH PHASE * MATRIX OF COMMUNITY OF INTEREST FACTORS * TRAFFIC SUMMARIES * TRUNK AND TRAFFIC MATRICES * TRANSMISSION MEDIA MATRICES * INVESTMENT IN NEW EQUIPMENT * INVESTMENT IN NEW PLUS EXISTING EQUIPMENT * COMPARISON OF ALL ALTERNATIVES

FIG.12

NETPLAN

TIME REQUIRED TO RUN THE SOFTWARE

1. PREPARATION OF INPUT DATA FOR PART ONE DATA BASE..2 TO 5 DAYS
2. PREPARATION OF INPUT DATA FOR EACH ALTERNATIVE....................................1 DAY PER ALTERNATIVE
3. RUNNING ALL PROGRAMS FOR ALL NETWORKS, ALL ALTERNATIVES................................1 HOUR

ALL DOCUMENTATION MAY BE PRINTED DURING PROGRAM RUNNING OR CAN BE VIEWED ON THE SCREEN, STORED IN MEMORY, AND THEN PRINTED ANY TIME THEREAFTER.

FIG.13

NETPLAN

SENSITIVITY ANALYSIS

THE PLANNING PROCESS INVOLVES A CONTINUING QUESTIONING

"WHAT HAPPENS IF....."

- AN EXCHANGE IS OUT OF SERVICE, or
- A FIBER OR PHYSICAL CABLE OR RADIO ROUTE IS OUT OF SERVICE, or
- A SIGNIFICANT TRAFFIC CHANGE OCCURS, or
- A NEW EXCHANGE IS CUT INTO SERVICE, or
- SUBSCRIBERS ARE TRASFERRED FROM A CONGESTED ANALOG EXCHANGE TO A DIGITAL EXCHANGE, or
- ONE REMOTE UNIT IS UPGRADED INTO A STAND-ALONE EXCHANGE,
- ETC., ETC.

A CHANGE OF A PARAMETER AT ANY POINT IN THE NETWORK RESULTS IN A CHANGE IN THE PERFORMANCE OF THE ENTIRE NETWORK, NOT SIMPLY IN THE ROUTING OF THE SECTION WHERE THE PARAMETER HAS CHANGED.

NETPLAN ALLOWS THE INTRODUCTION OF AN ADDITIONAL ALTERNATIVE TO EVALUATE THE IMPACT OF THE CHANGE ON THE TECHNICAL AND ECONOMIC PERFORMANCE OF THE ENTIRE NETWORK.

FIG.14

COMPETITION AS A DEVELOPMENTAL TOOL - THE NEW ZEALAND EXPERIENCE

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ABSTRACT

New Zealand in 1988/89 changed its regulatory approach to telecommunications and broadcasting to one of allowing open competition. The approach involves several innovative features which it is argued have helped utilise competition as a force for development and may be of interest to those considering options for developing countries.

INTRODUCTION

As some of New Zealand's approaches to telecommunications and broadcasting have been unusual, I will set out the New Zealand experience in the expectation that those who know their own countries' positions best can draw their own conclusions.

Particular issues to be covered include the overall New Zealand approach to telecommunications, how competition is utilised as a force for development, and possible implications for developing economies from the New Zealand experience.

THE NEW ZEALAND APPROACH

Since the early 1980's, successive Governments have pursued economic and structural reforms intended to lift New Zealand's economic performance. A greater market orientation and more reliance on competition have been elements in this.

Early steps included reducing import barriers on a wide range of goods. Typical tariffs on locally made telecommunications equipment such as telephone handsets, switching apparatus and antennae ranged from 35 to 45 percent before 1987. From 1996, they will be 13 percent. Substantial reductions are still being made, in order to encourage New Zealand manufacturers to concentrate on those products which can be made efficiently.

Not until 1987 did New Zealand establish telecommunications on a fully commercial basis. That year the New Zealand Post Office was split into three companies: banking, postal, and telecommunications (Telecom Corporation of New Zealand Limited (TCNZ)). Each was required to operate as a successful commercial business, with TCNZ being privatised in 1990. As separate businesses, they have prospered, ending the tendency for telecommunications to cross-subsidise the other two businesses.

The Government strove to place the companies in a position where they had neither advantages nor disadvantages compared to private counterparts. Removal of TCNZ's monopoly was a priority. Responsibility for providing policy advice on communications was shifted to a Government Department, now the Ministry of Commerce. Radio spectrum management was also transferred to the Ministry.

Broadcasting became subject to similar reforms in 1988. Until then, a state owned corporation, the Broadcasting Corporation of New Zealand, was responsible for running the only two television channels available, most radio stations and providing policy advice. It was an exception to the Post Office's telecommunications monopoly, being permitted to provide its own telecommunications systems.

Introduction of Telecommunications Competition

Competition was introduced into telecommunications over two years from 1987. First, customer premises equipment was progressively opened to competition. From 1 April 1989, all telecommunications services were opened to competition, including local and long distance voice and data services.

Competition was expected to put pressure on TCNZ to raise its game. Competition was seen, therefore, as both a device to raise New Zealanders' living standards and to improve the international competitiveness of New Zealand businesses.

The Government had some doubt about how far competition would extend. While business long distance services were expected to attract entrants, there was doubt about whether household customers and local access services would be so attractive.

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The major new entrant in long distance services is Clear Communications Limited which began providing service in May 1991. It formed from a number of prospective new entrants, including MCI and Bell Canada, with approximately 50 percent New Zealand shareholding.

Clear's shareholders included the two state owned enterprises providing television (Television New Zealand Ltd) and rail services (New Zealand Rail Ltd). They offered Clear a route to early entry, based on facilities they developed for their own internal purposes. Similarly, Electricorp Limited, another state owned enterprise, was able to sell fibre optic services to Clear. This avoided the need for initial costly replication of investment before competition could commence. Despite the indirect Government shareholding, the Government played no part in bringing the Clear shareholders together, other than offering a shareholder's consent to the state owned enterprises to participate at their own initiative, on normal commercial terms.

By September 1993 Clear had acquired an estimated 17 percent market share in long distance services. It has established relationships with overseas carriers using its own facilities. A toll free service has been introduced, as have calling card services.

Little progress has been made in the provision of local access services. Interconnection terms have not been agreed. Although Clear has installed local fibre in the central business districts of New Zealand's largest cities, interconnection terms have still to be negotiated. As at September 1993, a decision was awaited from the New Zealand Court of Appeal about interconnection terms. Clear has, however, been able to install a limited number of microwave links from its facilities to those of large customers to carry the originating local segment of long distance calls, which it would otherwise be dependent on TCNZ to provide.

Apart from cellular services, other major entrants have not emerged to date. Given the challenge of achieving economies of scale in telecommunications, this result is not unexpected.

New entry by competitors into providing and servicing customer premises equipment and customer wiring proceeded immediately. No difficult issues have arisen in these areas.

Broadcasting Competition

Limited entry into broadcasting was permitted with the approval of the Broadcasting Tribunal prior to 1989. This was subject to public hearings, consideration of whether detailed regulatory conditions would be met and consideration of the potential economic effects on existing operators. It was a recipe for litigation, including a three and a half year process to determine who should have the right to operate a third television channel. Shortly after the third channel did establish transmission in 1989, it went into receivership. The removal of foreign investment restraints in broadcasting in 1991 helped it to restructure and survive.

Full competition was allowed from 1989 onwards, unleashing a flood of new entrants. From July 1988 to September 1993, the number of sound radio broadcasters increased from 88 to 171. The number of frequencies registered rose from 157 to 420. The number of broadcast TV channels increased from 2 to 9, 7 of which are available nationally.

Pay TV (Sky) became established with three UHF channels available to the majority of the population and 17 percent market penetration in the areas of availability. Cable television is also in its infancy.

Radio Spectrum Management

A critical innovation enabling new services to be rolled out has been the move to a new system of radio spectrum management.

Before 1989, broadcast radio spectrum licences were available only with the approval of the Broadcasting Tribunal, usually after a semi-judicial inquiry. With the passage of the new Radiocommunications Act in 1989, the predominant means of issuing new spectrum rights became the tendering of 20 year licences, to manage either broad blocks (management rights) or single frequencies (licence rights).

Licences were fully tradable and not restricted to particular purposes, provided no interference occurred to other right-holders. Such rights have also been issued to holders of licences under the earlier regime, on payment of fees representing no more than 50 percent of the market value of the licences.

The main aim of the new system of spectrum management was to see spectrum allocated to the use of highest value to the community, based upon market values. The system enabled the rapid allocation of large quantities of spectrum including for cellular radio, sound broadcasting, UHF television and frequencies from 2.3 to 2.4 GHz. Other frequencies, such as for VHF television, will be brought into the new system, over time.

The new system has achieved its aims of rapid, fair allocation of spectrum to its most valuable uses. On-going market trading of rights eases movement of spectrum to new uses. Although not the primary aim, the Government has collected more than $NZ 60,000,000 ($US 33,000,000) from tenders.

Inevitably, there have been a few difficulties. There has been litigation. It is an almost inevitable consequence of allocating valuable rights, but particularly so under the New Zealand legal system, which offers private parties extensive rights to seek review of Government decisions in court. It has not delayed allocation much in most cases.

Higher levels of protection against interference within the new system have resulted in some inflexibility about the form in which licences can be issued. Such matters are currently subject to review. Overall, though, the system is seen to have worked well.

THE ROLE OF GOVERNMENT IN ACHIEVING NON-COMMERCIAL GOALS

A key ingredient of the New Zealand approach has been the use of a range of regulatory tools to achieve other Government objectives without restricting competition unduly in the process.

Competition Policy

Risks of dominance of markets are strong in both telecommunications and broadcasting. General competition legislation, the Commerce Act 1986, has been used to address such issues. It allows large mergers to be scrutinised and challenged, limits exploitation of a dominant position so as to reduce competition; and allows the Government to introduce price control measures. (The Government has not introduced telecommunications price controls under the Act to date.)

Private parties are able to initiate litigation to enforce the Act at their own expense.
The Commerce Commission is also established to enforce the Act.

Centralising resources in a general competition regime in this way, rather than establishing separate regulatory agencies for each industry, has a number of advantages. It concentrates limited competition expertise, it allows resources to be shifted about as issues arise in different industries and it is likely to reduce fiscal expenses.

General competition law is supplemented with specific regulations. International telecommunications service providers are regulated directly to allow safeguards such as proportionate return rules to be used where needed. TCNZ is required to disclose information about its financial results and the prices and terms on which it has offered services utilising its local loop facilities. The "Kiwi Share", a regulatory requirement applied via TCNZ's articles of association, requires TCNZ to limit increases in its local access charges to residential customers to the increase in the Consumer Price Index.

Undertakings to the Government to allow access to key facilities, such as high broadcast sites and TCNZ's local access network, are also an important part of the regime, as is the periodic restatement of Government policies to ensure that they are understood by all players.

Social Policies

A range of other socially, rather than economically, oriented policies require specific Government interventions. In telecommunications, these include:

- Rural customers' services are protected by the Kiwi Share, which requires TCNZ to maintain the geographical extent of its services to at least the level provided at the date of its privatisation. Rural residents may not be charged more than urban customers for local access.

- TCNZ must make a residential access package available without per call charging.

- General laws relating to matters such as privacy also apply to telecommunications.

In broadcasting they include:

- Promotion of New Zealand identity and culture, and installation of transmitters in sparsely populated areas is subsidised through the negotiation of contracts on the most favourable possible terms by a specialised Government agency. This agency, called New Zealand On Air, is able to take advantage of competition between all broadcasters to achieve the best value for money. State broadcasters have no automatic entitlement to resources and private broadcasters can help meet the Government's social goals too.

- Ethical standards covering violence, pornography and similar matters are enforced by an independent agency, the Broadcasting Standards Authority.

- Some frequencies have been reserved free of charge for non-commercial uses to provide absolute certainty of their availability, for example, for indigenous Maori broadcasting.

New Technologies

All countries wish to ensure that new or established technologies which offer advantages are taken up. Generally, the need to compete for business should provide strong incentives for telecommunications carriers to introduce such technologies, consistently with their own assessments of the risks and rewards.

New Zealand experience suggests that allowing competition has provided the expected incentives.

TCNZ was not early to introduce analogue cellular technology (1987) but was an early adopter of digital AMPS cellular technology (1992). Bell South's competing GSM cellular system, launched in mid 1993, also represents a relatively early introduction of a new technology. Telstra has acquired a third block of spectrum suitable for a cellular system and is understood to be planning to use it accordingly. Competition has certainly assisted consciousness amongst users of the potential benefits of cellular systems and helped to ensure that take up of the technology remains rapid.

Two frame relay services have been introduced, by TCNZ and New Zealand Post Ltd, the main provider of postal services in New Zealand. TCNZ has introduced basic rate and primary rate ISDN services. The latter, for which there is no competition and no immediate prospect of it, have been relatively slow to roll out and be taken up.

The Government has seen a need to more actively promote moves towards development of widely accessible broadband services. This is being done through the "World Communications Laboratory" (WCL) project, with small financial contributions from both Government and private sector agencies on a voluntary basis. A small staff has publicised opportunities to invest in and trial new communications technologies in New Zealand while promoting interest amongst New Zealand users who may know little about the potential opportunities for new applications.

New Broadcasting Technologies

Competition has induced earlier investment in provision of pay TV services. The proposed establishment of a cable system north of Wellington helped prompt the earlier expansion of Sky's pay services in the area. Such incentives would not have applied had sole operating rights in an area been awarded. There is no sign that services would be rolled out any faster in any area if exclusive franchises were awarded.

New technologies such as digital audio broadcasting (DAB), HDTV, and digital compression are closely monitored by New Zealand broadcasters. New Zealand is not often the first to apply such technologies. Without the economies of scale to support mass produced consumer product manufacturing and research oriented towards its needs, this is not surprising. What is possible is to be early, if not first. Allowing a great deal of commercial freedom also provides opportunities to developers of new technologies to test them

New Zealand broadcasters do continue to be innovative. One example is Radio New Zealand Ltd, which has put much effort into developing synchronous broadcasting techniques. Such innovation illustrates the importance of adopting technology suitable for local conditions, in this case New Zealand's hilly terrain.

The introduction of pay TV using encrypted transmission on UHF frequencies by Sky is another example of fitting available technology to local commercial conditions. The relative abundance of UHF frequencies made this the logical first step for the introduction of pay TV, rather than insisting that cable or DBS be adopted. The relatively low value of UHF frequencies was well established in the first frequency tender round in 1990. The most any of the packages of nationwide UHF frequencies on offer could fetch was $NZ 401,000.

IMPLICATIONS FOR DEVELOPING COUNTRIES

Results which may be of interest to developing countries fall into two broad categories. First, certain innovative policies and their outcomes may be of interest. Secondly, New Zealand experience in introducing competition highlights both opportunities and risks.

INNOVATIVE POLICIES

Innovative aspects of the New Zealand regimes for telecommunications and broadcasting include the market based spectrum management regime; the absence of a specific industry regulator and reliance on general competition law in telecommunications; and the combination of open entry into broadcasting with competitive bidding for public funding to achieve social goals.

Spectrum Management

The new market based spectrum management system has demonstrated its worth. In short, it is an option worth considering where demand for spectrum exceeds supply.

The system has moved a great deal of spectrum to its most highly valued uses quickly. Less time and resource has been needed to assess the suitability of potential spectrum buyers.

The New Zealand Government has raised small amounts of revenue. As the main aim was to see spectrum used to maximum public benefit, large windfalls were never likely. Cellular rights stand out as being particularly valuable and accordingly very suitable for allocation by tender.

Also of interest is that user charges are capable of generating sufficient revenue to cover the costs of spectrum management operations. The expected value of user charges over time may even exceed the value of spectrum sales even though charges to users have been lowered as increased usage of spectrum has allowed them to be spread more thinly.

One possible constraint on proceeding with similar spectrum management policies elsewhere would be a shortage of spectrum management and commercial expertise. Users have had to learn how spectrum markets will operate. Such expertise takes time to develop. Even now, it is unclear whether there are sufficient people and organisations in New Zealand with the skills and interest necessary to allow private spectrum management to develop fully, apart from in organisations whose management of spectrum would raise competition problems.

Telecommunications Regulation

Having no telecommunications specific regulatory agency is unusual where competition has been introduced. New Zealand demonstrates that it is quite possible for competition to begin without such an agency and without close supervision of the basis of competition.

Where competition has been introduced, prices have fallen sharply, to the benefit of consumers and business competitiveness. For example, the real price of long distance calls to consumers fell by 37 percent from the quarter before competition was allowed to the June Quarter of 1993. There is a widespread perception of improved service standards. Published indicators show improvements in service, including in areas such as reliability of access and time taken to have a telephone installed.

There are benefits in proceeding without a special regulatory agency and detailed rules. Lower fiscal costs of regulation, lower compliance costs for carriers and more flexibility for carriers are amongst them. There is a diminished need to call on scarce skills to supervise regulatory issues. There is less risk of regulation becoming an industry in its own right.

It has also been shown that an adequate competition law regime is needed to ensure that the full benefits of competition will emerge. In the absence of industry specific regulation, the only incentives which TCNZ has had to agree to interconnection have been the moral force of the undertakings to Government to provide it, the prospect of adverse court rulings under the Commerce Act, including damages for blocking competition and the prospect of further Government regulation of a more intrusive nature if interconnection is not provided.

It seems likely that for new entrants to finally succeed without detailed supervision of the terms of interconnection, entry into a broad range of markets will be necessary over time. Without this, new entrants are likely to be dependent upon established competitors to provide critical links to parts of their markets. Local entry then becomes very important, even though there are yet few well established principles upon which it can proceed. The results of the local access court case between Clear and TCNZ will then be very important to the New Zealand regime.

The combination of a commercial environment plus competition has certainly been a potent way to improve industry efficiency. From 1987/88 to 1989/90, value added per full-time equivalent persons engaged in telecommunications rose by 27 percent. Telecom has improved the number of access lines per operating employee from 117 to 171 in the two years to 1993. Interestingly, while TCNZ has shed large numbers of employees, it is apparent from official statistics that overall numbers of employees in Telecommunications have fallen much less. Overall expansion in the industry has been able to absorb much of the excess labour released by efficiency improvements.

Public Funding of Broadcasting

The establishment of New Zealand On Air as an agency to negotiate contracts to achieve public broadcasting goals has been very successful. This has of course been possible because of the introduction of competition in broadcasting. There is always a risk that if a subsidy is made available to only one agency to achieve a particular goal, the staff of that agency will capture the benefit rather than those for whom it was intended. In moving away from funding social broadcasting goals almost exclusively through the state owned broadcaster, New Zealand seems to have reduced such risks.

Local content in the three main television channels has increased from 1424 to 2526 hours in the five years to 1993. Only a small proportion of this could be attributable to increased revenue available over the period. Moreover, this was achieved at a time when the industry has attained overall profitability, when expensive types of programmes such as drama have increased considerably in volume and in the absence of local content quota requirements.

Funding of extensions of television coverage to remote regions is also interesting. Before 1989, the state television company had achieved in excess of 99 percent population coverage with its services. It maintained that extension beyond 90 percent coverage was probably uneconomic. New Zealand On Air continued to fund Television New Zealand Ltd at similar levels for carrying out this activity to those which the state broadcasting agency had funded itself historically. In 1990/91, approximately $4.5 m of funding was made available. By 1993, the privately owned TV3 out of its own resources was close to completing an expansion of coverage to 93 percent of the population. New Zealand On Air reduced funding to Television New Zealand Ltd to approximately $0.6 m in 1992/93.

While the issue is not yet fully settled, it would appear that the costs of providing rural coverage under conditions of competition are very much less than under a monopoly.

This suggests that the possibility of looking for opportunities for competition in providing rural services should be explored where possible. This is not to minimise the very real difficulties in providing full rural coverage in any environment in either telecommunications or television. The process has been a long one in New Zealand. Rather, it is to suggest that opportunities for competition not be overlooked.

OPPORTUNITIES AND RISKS OF UTILISING COMPETITION BASED STRATEGIES FOR DEVELOPMENT

A number of positive and negative aspects of utilising competition as part of a telecommunications strategy have already been highlighted. This section of the paper summarises some possible lessons arising from New Zealand's experience.

It is worth exploring the scope for competition. It may be more feasible than you think. In allowing full competition, the New Zealand Government could not be at all sure that competition would occur in certain industry segments, such as local telephone access service, cable TV and television services in most rural areas. The prospects now look better in each of these areas. On the other hand, it is likely to be very difficult to establish competition in some markets.

Where competition can be established, good results can be achieved. Competition in New Zealand telecommunications and broadcasting appears to have brought substantial service improvements and price reductions. The price reductions improve communications by encouraging greater use of the services.

Competition can reduce the need for detailed day to day supervision of industry activities. Allowing competition can help to reduce direct regulatory costs, as there is less concern that industry participants will set prices at levels which require regulation and less concern that special incentives need to be applied to ensure that desirable innovations will be adopted.

Competitive markets can provide a good means of determining appropriate industry structures. New Zealand examples include leaving market participants to establish the appropriate structure for pay TV and establish the appropriate structure for the major new entrant into telecommunications.

Competition may well help to reduce the cost of achieving Government objectives such as expanded coverage. New Zealand's broadcasting experience provides evidence.

Even in telecommunications, although achieving rural coverage may be less economic than urban coverage, New Zealand's experience offers some prospects that appropriate incentives can be created. The Kiwi Share mechanism only requires TCNZ to maintain, not expand, rural coverage. TCNZ has, however, been prepared to offer additional rural coverage where required (although seeking reimbursement of up to 70 percent of excess capital costs in very expensive areas) and to continue to upgrade poorer quality rural services over time, although not explicitly required to do so. Understandably, such upgrades are being undertaken after the completion of upgrades to urban services.

A competition based strategy can certainly help to attract capital and technology. Investment by Bell Atlantic and Ameritech in TCNZ (and in Sky with TCI, Time-Warner and ESPN); MCI and Bell Canada in Clear; Bell South and Telstra in cellular ventures; and CanWest in TV3 has illustrated the real value of allowing foreign investment.

New Zealand capital has also been available, but New Zealand business would have been unlikely to take up all these opportunities. New Zealand had neither the commercial experience nor the technical experience, at least outside state owned ventures, to attempt to take up some of these opportunities. A positive approach to foreign investment has been very helpful.

Competition brings a greater risk of business failure. TV3 established itself without special privileges and despite initial severe restrictions on foreign investment. It went into receivership approximately four months after commencing transmission. Such results are more likely where open competition is allowed. Fortunately, with a flexible approach to investment, no major services (as opposed to company structures) have failed.

Competition based regimes still require regulation. The form of the regulation may be different but it is still needed. A strong competition law is essential to resolve disputes such as those over interconnection. This perhaps remains the major test for the success or otherwise of New Zealand's approach to telecommunications.

New approaches to old regulatory issues such as spectrum tendering and New Zealand On Air as a funding agency helped make the introduction of a high level of broadcasting competition possible.

Sophisticated approaches require sophisticated businesses. It has taken time for some of those interested in spectrum rights to become fully familiar with the new system. A number of participants in tenders have been surprised by the technical characteristics of the spectrum rights they have won, having failed to understand what they were buying. Instances have occurred in which widely differing prices have been paid for seemingly similar spectrum rights. This suggests a need to ensure that those expected to cope with the effects of innovative policies have a good chance of doing so.

CONCLUSIONS

Over 1988 and 1989, full competition was introduced to New Zealand telecommunications and broadcasting. State enterprises were expected to operate in a commercial manner.

Although it is axiomatic that developmental approaches must be developed to suit local conditions, the New Zealand experience may be of interest to developing countries in showing the potential to use competition as a developmental tool. Allowing a competitive environment is worth considering, even if the prospects for competition are uncertain.

Competition can be a spur to development. It can provide incentives to introduce new technologies. It may help to attract investment and technology, including from foreign sources. It can allow a Government to step back from day to day supervision of telecommunications activity, allowing private entrepreneurs to determine the best structures and approaches for providing particular services.

Allowing competition may simplify regulatory issues but it is likely that new regulatory measures will need to be developed to accompany it. In New Zealand's case, these have covered such matters as providing funding through contracts to achieve particular policy goals, specific obligations on TCNZ and developing a new market based system of radio spectrum management.

A strong competition policy regime is desirable if telecommunications interconnection is to proceed.

New Zealand would not claim to have a blue print for successful development of telecommunications and broadcasting. However, its experience does illustrate the scope for harnessing competition as a positive force for development.

VSAT Service in the Pacific: The Next Trend

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1. ABSTRACT

Recent satellite advances and regulatory change are making international VSAT services an important growth market. This paper presents recent case studies for VSAT networks via INTELSAT satellites.

2. Introduction

International VSAT services are available today through COMSAT World Systems. The expansion of this market is abased on the global coverage provided by high power INTELSAT satellites and the essential deregulation of telecommunications markets worldwide. To date, COMSAT customers have made a substantial commitment to international VSAT services. We, and our U.S. customers, see VSAT as an important new growth market for INTELSAT.

Growth in telecommunications demand in the Pacific Rim, and the introduction of the first INTELSAT VII satellites this year, will lead to an increase in Very Small Aperture Terminal (VSAT) networks in the Asia/Pacific Region. The INTELSAT VII series satellites, which are being deployed first in the Pacific region, will feature even higher power than the INTELSAT VIs and therefore will be easily accessed by VSAT antennas.

COMSAT will present our experience in implementing international VSAT services via INTELSAT, in terms of technical feasibility and the reality of the competitive environment today. Thanks to INTELSAT's new, higher-powered satellites and the changing competitive environment, international VSAT services are a here-and-now option for global communications.

As the U.S. Signatory to INTELSAT, COMSAT is fully committed to establishing international VSAT service requirements via the INTELSAT satellite system. COMSAT is a U.S. corporation, 100% publicly owned, and formed in 1963 by an act of Congress. COMSAT has 5 business units, which provide a range of communications services. COMSAT World Systems' customers include U.S. International Carriers and other users authorized by the Federal Communications Commission (FCC). Services include voice, video and data.

3. U.S. Domestic VSAT Business

U.S. customer expectations are based on nearly ten years' experience with domestic VSAT networks. Over 300 U.S. corporations have VSAT networks in the U.S.; this represents a sizeable target market for international VSAT networks. Over 90% of the applications are data.

With fiber optic networks so extensively available, why are VSATs chosen in the U.S. communications environment? VSATs have several inherent performance advantages over terrestrial alternatives, including: fewer discrete points of failure, simpler network deployment, more flexible network configuration, simplified network management, and a proven track record of cost-effective performance.

3.1 Market Requirements

COMSAT recently completed a market study about the needs of U.S. customers for international VSAT services. Here are some things we have learned. Many U.S. multinationals need to extend their U.S. networks internationally.

Their requirements include: desire for increased control of multinational networking, improved cost-performance factors, independence from domestic infrastructure, network flexibility, and the need to service remote locations. VSAT services offer these benefits by connecting sites in multiple countries through a single technology.

4. VSAT: Competitive Service

Customers see clear advantages to establishing international VSAT services through INTELSAT, including the system's global and hemispheric connectivity. Competition to satellite communications and the INTELSAT system is here today and will accelerate. The international VSAT business will be won or lost based on the ability to serve customer needs with realistic prices, high quality, and reliability. Meeting customer needs in today's increasingly competitive marketplace is vital, and these needs in many cases will either be met by the INTELSAT consortium or they will be met by separate systems.

COMSAT has worked cooperatively with INTELSAT Signatories to provide a competitive alternative to other telecommunications options, which includes reasonable, cost-based pricing, and simplified technical and administrative procedures such as "one-stop" billing arrangements.

As an example of a simplified approach for interactive VSAT networks, COMSAT has proposed that the country with the hub in an international VSAT network should take the responsibility of administering the space segment lease and distributing monthly revenues among participating Signatories.

COMSAT has taken an active role in facilitating network arrangements for our customers, and is actively promoting the commercialization of these services with our fellow Signatories in INTELSAT. In late 1992, the first of these global VSAT networks was implemented when MCI inaugurated its service for Holiday Inns to Europe on the INTELSAT VI. Similarly, in 1993 the first interactive VSAT networks with services to Latin America were implemented by both AT&T and MCI.

As we will illustrate, our case studies show that VSAT solutions on INTELSAT satellites compete technically and cost-effectively with other communications solutions, as well as providing the services that U.S. customers want.

4.1 **VSAT versus IBS Market Requirements**

We believe that VSAT services are both complementary to the IBS market, and an important value-added growth market. Furthermore, VSAT applications are low to medium speed, distinct from IBS applications. In many cases, VSAT is an entry level private-line service meeting an otherwise unserved market requirement. While IBS applications occur as 64 kb equivalents, typical VSAT applications require 9.6 kbps or lower on a TDMA basis. Interactive VSAT applications tend to have as many as 100 sites sharing a single 64 kb inroute.

We suggest a means of translating space segment usage for VSAT into a bits per second rate. This approach illustrates the low speed data applications typical of VSAT networks. The generic formula takes specific parameters of each network to arrive at an average data rate per site. Parameters include: inroute speed, number of VSATs, efficiency factor of transmission, and number of networks sharing inroute.

In a representative network, an inroute with a data rate of 256 kb is shared by 37 sites. The gross information rate per site is about 7 kbps. Assuming an efficiency factor of 15%, the average data rate is closer to 1 kbps per site. These examples should lead to pricing VSAT services appropriately below tariffs for IBS. Realistic, cost-based pricing will stimulate the VSAT market, and enable this emerging global market to be served via the INTELSAT satellite system.

5. **Recent Satellite Advances**

The new, higher-power INTELSAT satellites are making international VSAT services even more attractive. Higher-power satellites, Ku-band between the U.S. and Europe, and C-band throughout the Americas, are here now. They make the installation or expansion of VSAT networks internationally a cost effective proposition for many multinational corporations. This is part of a trend in the industry, away from urban gateway stations to smaller, on-premise facilities.

The INTELSAT VI series, in service over the Atlantic Ocean Region, provide power and coverage competitive with or superior to other international satellite systems to Europe and Latin America. For example, the Ku-band coverage of Europe via the 335 degree east satellite, with beam edge power of 44.7 dBW, allows for 1.8 m VSATs within the beam edge. The 325 satellite provides single beam coverage of Latin America and the Caribbean; the beam edge power of 31 dBW in C-band allows for the use of 2.4 m dishes throughout the region. Likewise the 325 satellite provides virtually full coverage of the African continent, plus much of the Middle East, as well as Western and Central Europe.

With the introduction of the VIIs, we expect that U.S. customers will want to extend VSAT capabilities into the Asia/Pacific regions.

5.1 **Case Studies**

Here is what the current and planned high-powered INTELSAT satellites mean to VSAT networks. We will illustrate typical interactive, star VSAT networks to all regions. All of the examples assume the use of an outroute with an information rate of 256 kb, and inroutes totaling 128 kb. IBS performance characteristics are assumed throughout.

Our analysis shows that a VSAT network between the U.S. and Europe operating in Ku-band on today's INTELSAT VI satellites requires only 1.4 MHz operating to 1.8 meter remotes in Europe, and leased bandwidth of 1.2 MHz for operations to 2.4 meter remotes.

For services to Latin America, the same network in C-band uses 3 MHz operating to 2.4 meter remotes, and 1.4 MHz operating to 3.8 meter VSATs. The INTELSAT VI provides similar performance levels serving Africa and the Middle East.

VSAT services to the Pacific region via the INTELSAT VII satellites will use 2.4 MHz of leased bandwidth in C-band operating to 2.4 meter remotes, and 1.2 MHz operating to 3.8 meter VSATs.

6. Conclusions

These case studies illustrate the shrinking network costs we can expect with VSATs located at customer premises, operating from hubs near a U.S. multinational's data center. In designing a VSAT network, the customer has great flexibility in making economic tradeoffs based on the size of the VSATs implemented, performance parameters, and the high-powered INTELSAT satellites.

On behalf of our U.S.-based customers, we are working to expand VSAT networks overseas, from the U.S. to remote locations in Latin America, Europe, Africa, the Middle East, and Asia/Pacific, using INTELSAT's high-power satellites and existing VSAT technology.

Clearly, VSATs are an important alternative for multinationals with operations around the globe. For these reasons, COMSAT stands ready to provide the essential satellite links that will make these networks possible.

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THIN ROUTE NETWORKS FOR THE ASIA PACIFIC REGION

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Traditionally, the Asia Pacific region has been both under served and poorly served by existing communications facilities. It is the premise of this paper that satellite capacity and services tailored to suit the needs of this area in a manner not previously done by the existing systems in the region, can significantly enhance the economic well being of emerging/developing areas in the Asia Pacific region. Low cost, high performance satellite capacity designed to support "thin-route" VSAT applications will satisfy demand that cables, by their very nature, cannot meet, and which the next generation of satellites have not yet been deployed to fill. The existing providers of telecommunication services have so far focused largely on the Public Switched Telecommunication Network (PSTN). They have established "trunk" routes connecting PSTN networks within each nation, with emphasis on the major routes between major cities.

There has been little attention paid to meeting the needs of "thin" routes, which include private or closed networks connecting points in major commercial centers of the region as well as PSTN traffic to outlying and difficult to reach areas. As a result, the rapidly growing needs of businesses to network with their overseas offices are not being adequately serviced by existing PSTN-focused telecommunication networks. Outlying areas like the Pacific Islands and certain areas in developing countries are also not getting adequate service.

There are many reasons for these past trends. High capital costs and perhaps most importantly the high incremental costs for spreading out terrestrial network coverage geographically, made engineering high volume "trunk" routes more economical and thus a preferred focus of attention. The installation of submarine cables in the Pacific has cost from several hundred millions of dollars to in excess of $1 billion to connect a handful (1-3) countries/land areas each. When INTELSAT earth stations were being introduced into many of the Pacific Island communities in the late 70's and early 80's, these costs often exceeded $1 million per site. Even today the cost of a small international gateway earth station is several hundred thousand dollars. Such enormous costs made it uneconomical and unfeasible for many developing areas or private enterprises from receiving any level of communication services other than HF radio or plain old telephone service. Not surprisingly, established carriers also concentrated on those areas with large population centers and economies where the level of activity justified such large capital investments. However, it has been shown time and again that the lack of a good telecommunications infrastructure can retard economic growth and activity.

In addition, the supply of facilities has had difficulty keeping up with the rapidly growing demand in the region. The lead time for any major cable or satellite system is several years, requiring a strong capital base and long term funding, which traditionally only a few large organizations have been able to accomplish. In the past there have been major structural and regulatory barriers with any provider of service covering different national markets. Among the latter are the legal and structural framework of the telecommunications industry in each country and international telecommunications agreements, as well as the protected nature of many telecommunications markets. These circumstances have prolonged the process and increased the cost of installation and operations of new and expanded telecommunications facilities in the region. Even when such barriers are overcome, the complexity and cost of a private international network can be astounding. For example, a three site network can involve five to seven different carriers and four or more types of transmission technology. This results in no single "manager" of the network as well as multiple and repetitive costs (including each carrier's profit margins) to the end user.

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As a result, private and other "thin route" networks have had to piggy-back on "trunk" PSTN facilities and thus live with limited and expensive service. Less developed markets in the region, for example, have been forced to wait until their international traffic was at a relatively high level before they could justify being provided with high quality service. It is the pent up demand in these neglected "thin route" markets, i.e. the private business telecommunication networks as well as the PSTN traffic of outlying areas, on which private satellite systems should provide more focus.

In addition, there is a need for satellite services and facilities within the Pacific Islands. At present, communications to and from the Pacific Islands are constrained by the lack of essential infrastructure. A facility can be designed which would not require an established and sophisticated infrastructure. Such a system would thus allow this region to fully participate in the world economy through affordable ownership in a system tailored to meet the specific needs of these countries. Some island nations are sufficiently developed to have sophisticated communications needs while other less developed Island countries need these communications facilities basic telecommunications services to assist in their economic and social development.

Clearly there has been need for satellite facilities for communications services within the Asia Pacific region, and, as development in the region progresses, even greater demand will develop for communications services and facilities. A new approach needs to be implemented which is based on a niche-oriented communications network architecture that is technically and structurally unavailable in the region today. The principal operators in the Pacific market concentrate primarily on building facilities and providing services in the dominant public switched voice market segment, focusing on the major routes. While "thin route," private line and nascent private network offerings exist and are growing, current implementations are costly, limited in scope, and technically cumbersome.

In this environment, a solution to the problem would be to:

- Offer services which undersea fiber cables cannot competitively provide, through the use of facilities that require no established infrastructure and which can be operated using VSAT terminals.
- Offer services which meet known customer needs, but which cannot presently be obtained because of technical constraints, facility unavailability, or high costs.
- Offer private networking services which existing carrier arrangements can not structurally supply, including direct premise-to-premise international communications via satellite.
- Offer high quality regional and domestic switched voice, data, and video services where none exist today.

This multi-pronged approach affords the ability to provide a niche oriented communications network architecture that is technically and structurally unavailable today. One method of providing the solution would be through the use a Ku band satellite employing multi spot beams to achieve very high EIRP. Higher power levels (about 50 dbw EIRP) through the use of small spot beams, could be put over heavily concentrated urban areas where space is at a premium and smaller VSAT's (1 - 2 meters) would be better suited. In more remote areas and widely dispersed island regions, larger beams could be placed having lower power levels (mid 40 dbw EIRP). In these areas slightly larger VSAT's (2 - 3 meters) could be installed. In both cases the equipment cost of such installations today would be about $30,000 to $45,000, with the likelihood of even lower costs in the future, probably well under $10,000 before the end of the decade.

As VSAT technology evolves, the use of mesh networks will become possible on a reasonable cost basis. Such a network could easily be installed employing just VSAT's without the need for a large and expensive hub and central reference station. It is been Orion's belief, that a system of 6 or more sites using mesh can be operated today for under $50K per month if an appropriate satellite with sufficient power and coverage is available. As technology improves and competition expands, the resulting increased volume of production and provision of service, should drive the costs of such services in a simple application configuration (e.g. 2 voice, a fax and a data channel) down to levels approaching $10K per month by the end of the decade. Such a system could allow groups of outer islands to be directly connected to the capital or other primary commercial center(s) for a reasonable cost. This would make available emergency services, commercial scheduling, and plain old telephony types of applications available to most all areas within the Pacific Islands.

Such a system would generally require much higher power and different coverage patterns than currently in operation or planned for the Asia Pacific region. While some of the new satellite systems plan to use higher power Ku band capacity most of the systems only cover limited geographic areas and are predominantly targeted to serve the larger PTT's and television/cable markets. However, such a system could provide enormous financial benefits for the operators, businesses and individual nations, should it be implemented. Orion is planning a system that meets both the needs of the traditional telecoms users and thin route and private network applications. It is planned that our system(s) will be operational in 1997 with the anticipation of other suppliers/carriers following this approach in a more limited fashion.

RURAL TELEPHONY: A new approach using mobile satellite communications.

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1. ABSTRACT

Rural telephony has traditionally been a subject present in most developing countries' projects. Usually rural satellite telephony involved the use of VSAT systems, developed for commercial data applications in urban environments. To support rural telephony, VSATs have undergone some changes, but the resulting VSAT "rural" networks have costs that limit its implementation in developing countries. One answer to the rural telephony problem currently being evaluated in Mexico involves the use of L-band, mobile satellite communications' telephone terminals. This paper describes the different aspects involved in the use of mobile satellite terminals for rural applications in Mexico, and mention present and future developments in the world through different mobile satellite systems.

2.- INTRODUCTION

The subject of rural telephony has always been a high priority in every country, since it plays an important part of the country's infrastructure. It is also known that though important, it is a very difficult, complex and expensive task to communicate rural, remote or inaccessible locations, specially in large countries. If that premise holds true in highly industrialized countries, it is much more dramatic in developing countries, where a large amount of the population lives in small, dispersed rural communities. Many of these countries have large territorial areas or uneven terrain, difficulting the installation of terrestrial telecommunications networks to provide public telephony access to remote communities.

A problem often mentioned in rural communications is the low revenue generated by the service provider. This is due to low telephone traffic and the generally low income of the rural population, which severely limits their access to the PSTN. Rural telephony then is viewed as an object of purely social interest, and rather a financial burden for governments for subsidiary reasons. A different point of view presented here could help things change.

If rural telecommunications were considered as primary infrastructure, the investment could be a strong push to the developing countries' rural economies in both production and commercial levels, generating a higher personal income, as it happens with roads and highways. That is an interesting suggestion, but it has to fit into the developing country's budget to be attractive, and that is the problem with the currently available technology.

Rural Telephony also has been the interest on international entities such as the International Telecommunication Union (ITU) on its different reports and declarations. On its "Report of the Independent Commission for World-Wide Telecommunications Development" (Dec. 1984) it states that "... Conditions in remote and rural areas suggest that satellite or radio systems may offer cost effective solutions ..." (Rec. 20). Besides that, on its Declaration of Acapulco (Americas Telecom, Apr. 1992) it asks " To supply telephone access to rural communities... through the opportunities that new technologies bring". The same declaration also asks "To promote regional integration through modern telecommunications technologies, such as fiber optic, satellites and digital networks."

The most common communications systems traditionally used in rural applications are cable and VHF multiplex radio. The obvious implications of cable are its limitations in coverage due to distances involved (cable and posting), whatever topology is used. As for multiplex radio, it has more advantages than cable, up to a point where the distances and atmospheric effects also limit the system's capabilities for good, reliable communications. Microwave radios provide high circuit capacity ideal for trunking applications, but they are not a last mile solution. Besides, the use of repeaters always increases the operational and maintenance problems due to natural (bad weather) or provoked (vandalism) causes.

Each of the above systems cannot solve the rural problem by itself, but are important part of the overall solution. These systems, and others to be mentioned later in this article, can combine these technologies. This combination can bring a strong technical standpoint, which makes the search for a common solution even more important. Besides, each country may need a different combination of technologies based upon its own social, political, geographical, technical and economical characteristics.

The Telecommunications Group of CICESE Research Center has worked for over 15 years in the study of the rural communications situation in Mexico, and has searched for high level technology that can solve the country's rural telephony problem. When large communications coverage is required, the first word that comes to mind is "satellites." The use of satellite communications solves the coverage and availability problems quite easily, but it then confronts the user with the gigantic initial investment required to start operations. Added to this are the operational costs involved in satellite transponder fees, call routing and billing, and finally access and use of the PSTN. Standards and compatibility between systems are of crucial importance also. It can be seen then, that there is not a simple solution for the rural telephony problem, and bold, new ways to solve it must be studied and analyzed, based upon the emerging technologies worldwide.

3. FIXED AND MOBILE SATELLITE COMMUNICATIONS.

Ever since the conception of satellite communications, it has been repeatedly mentioned the fact of its great coverage. That is one of the main attractives for satellite networking in large areas, and since the coverage depends upon the satellite's antenna design, it can improve even more the communications network's parameters. Satellite communications systems can be either fixed or mobile, depending upon the earth station and terminal's type and technology, the frequencies and bandwidth used, and the satellite itself. The history of mobile satellite communications is remarkably similar to that of fixed satellite communications, with only over a decade of delay.

3.1 FIXED SATELLITE COMMUNICATIONS.

Due to the huge success on satellite communications in the 1960's by the international consortium INTELSAT, based upon the global coverage of the 5 continents, some countries decided to have their own domestic satellite system. This process started with the Canadian (Anik) and Indonesian (Palapa) satellite systems in the early 1970's. Presently there are many domestic and regional satellite systems in the world, belonging to both developed and developing countries.

One particular characteristic of all these systems, is that they require the use of fixed earth stations in both ends of the satellite link. The main symbol of these earth stations used to be large and expensive parabolic dish antennas, but now advances on satellite and earth station's technology allow the use of smaller antennas and terminals, though they still require the fixed antenna pointed to the satellite.

3.2 MOBILE SATELLITE COMMUNICATIONS.

As mentioned above, the mobile satellite communications' development is almost identical with its fixed counterpart with the delay due to the almost non existing demand of mobile services, and the early stage of mobile communications' technology.

During the mid 1970's a global satellite communications system for ship applications, MARISAT, was developed (1). By the end of that decade, an international consortium for maritime satellite applications was created under the name of INMARSAT, taking control of the U.S. Marisat satellites. As this new organization turned to open commercial operations, it covered its growing demand of transponder bandwidth through the lease of INTELSAT V and European MARECS satellites. Just as its predecessor INTELSAT, the objectives of INMARSAT were to give complete communications access to ships located in any body of water in the world during its sea voyage.

This "mobility" concept soon jumped to aeronautical and finally terrestrial applications for both voice and data, as the number of INMARSAT users continued to grow (2). Then again, just as it had happened before, some countries saw the advantages of having a domestic mobile satellite system covering only a specific country or region. Presently, only Australia has a domestic mobile system (Mobilesat), based on the AUSSAT-B satellites. There are also other similar systems in advanced developing stages such as the U.S. and Canada's MSAT and Mexico's Solidaridad, to be initiated during 1994.

The main concept in mobile satellite is the possibility to communicate voice and/or data from any vehicle or place in the world in global systems or area of coverage in domestic systems. To be able to do this, it would require only a small or portable equipment with minimum restrictions for antenna pointing, and total access to private or public communications networks [Fig. 1].

3.3 FREQUENCY SPECTRUM AND ASSIGNED BANDWIDTH.

As mentioned before, the differences between fixed and mobile satellite systems are not only technological but also operational in aspects such as frequency spectrum and assigned bandwidth. This is an area of permanent controversy, since the frequency spectrum is a limited resource with ever growing demand. Unfortunately, mobile satellite's technological advantages are also its spectrum disadvantages, as will be described next.

Most fixed satellite systems use both C band (6 GHz uplink/4 GHz downlink) and Ku band (14 GHz up/11-12 GHz down) for its usual satellite communications links. The bandwidth assigned to these bands is 500 MHz each, which through the use of frequency and polarization reuse can double many times its capacity. These frequencies also require the use of directional parabolic antennas with high gain in terrestrial stations. This fact helps to get high quality signals with ample bandwidth, but it plainly hurts its possible mobility. That is the reason for which they are called "fixed" earth stations.

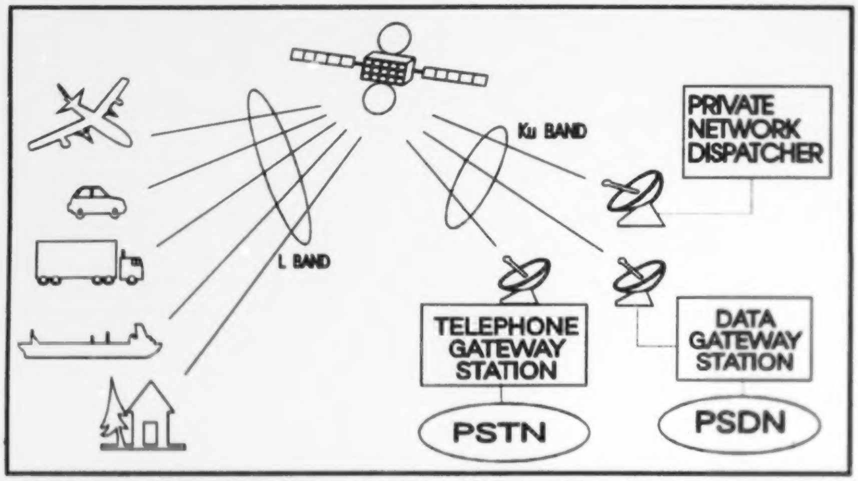

FIGURE 1. INTERCONNECTION TO PUBLIC AND PRIVATE NETWORKS

As for mobile satellite systems, they usually use L band (1.6 GHz up/ 1.5 GHz down) for its mobile-satellite links, and C or Ku band for its satellite-land earth station feeder links. One advantage of L band is that it does not require the use of directional antennas, but rather of small omnidirectional or planar array antennas with circular polarization. This permits the mobile communication link to continue even on the vehicle or ship's movements and changes of direction. Besides, L band is not affected by atmospheric effects and attenuation, important factors for C and specially Ku band. On the other hand, the main problem with L band is its reduced assigned bandwidth of only over 30 MHz, which is also divided into maritime, aeronautical and terrestrial applications, severely limiting the available volume of traffic. This problem is a consequence of the following aspects:

- its late entrance into the satellite arena,
- its initial "ships only" and "low traffic" orientation,
- the fierce battle for spectrum from and between land mobile systems (cellular, trunking, wireless, etc.),
- the simple radio transmission requirements, which make L band a very coveted spectrum section for radio and wireless users, and
- the relatively low frequency location of L band as a RF carrier, which seriously limits its available bandwidth.

One extra problem is that any global beam in L band will subtract an important part of the available bandwidth in that hemisphere, reducing even more the remaining bandwidth. This subject is continuously confronted in the spectrum negotiations among the potential operators and users involved, and is coordinated internationally by the CCIR and ITU organizations.

Based on the arguments described above, it can be seen that terrestrial applications were a last-minute addendum on the spectrum distribution debates. Besides, it has been mentioned that terrestrial applications were strongly backed for moving vehicle applications. This aspect reduces even more the semi-fixed rural applications to a very weak presence from the bandwidth point of view.

4. CURRENT AND FUTURE SATELLITE SYSTEMS

There is a growing number of mobile satellite systems emerging in the world at this time, which can be gathered into two main groups. These two groups are based upon the satellite system's orbit around the Earth, being Geostationary (GEO) and Low Earth Orbit (LEO) satellites.

Although all current mobile satellite systems are of the GEO type, there is a rapidly growing number of LEOS, based on multiple-satellite networks at low orbits. LEOS will bring unseen changes in all communications aspects, due to its amazing technology advances. LEOS have many advantages over GEOS but will be more complex and expensive to operate. While GEOS are usually promoted by national communications administrations and entities, LEOS are the product of big, high-tech private companies or joint ventures. Mobile communications GEOS are already here, while LEOS are still in its early developing tages, but eventually they will have to coexist. Since there are many different systems already proposed or working, a short description of some representative systems will be presented.

4.1 GEOSTATIONARY EARTH ORBIT SATELLITES (GEOS)

Due to its orbit and distance from the equator (36,000 km), GEOS stay at the same stationary position from the earth point of view. Such distance causes a time delay of over a quarter of a second, which can be annoying in telephone applications if the satellite terminal is not properly adjusted. Besides, it causes a high signal attenuation due to propagation losses.

INMARSAT. It was the first mobile communications system in the world, and has over a decade's experience in mobile services. It is a multinational organization that offers telephone, data and facsimile as well as distress and safety communications. It serves all maritime, aeronautical and land mobile applications through its different A, B, C, M and AERO standard terminals (3), (4). Its M service started operations in 1993, allowing digital telephone transmission from a briefcase-sized portable terminal. It offers access to public communications networks through feeder link earth stations located in strategic places of the world. INMARSAT has a global coverage service by the use of GEO satellites in four regions of the world. It currently owns two Marisat and two INMARSAT satellites, and it leases transponder capacity on two European MARECS and three INTELSAT V MCS satellites. Due to its early arrival to mobile communications, INMARSAT has been assigned a substantial part of the L-band spectrum.

MSAT.- It is a joint project between the U.S. and Canada, aimed to provide mobile communication service for the North American region, the Caribbean, Alaska and Hawaii. It is initially based on two powerful GEO satellites, one provided by the U.S. (AMSC) and the other by Canada (TMI). It will offer digital communications for telephone, data and facsimile services on all maritime, aeronautical, land mobile and fixed site applications (5). It will be able to communicate mobile users to public and private networks on an easier format than that of INMARSAT, through the use of several gateway earth stations. It also will offer a unique dual telephone service compatible with both satellite and terrestrial cellular networks, transparent to the user. The mobile terminal will consist on a vehicle mounted unit, a hand-held unit and a planar-array exterior antenna. It is expected to start operations during 1994.

SOLIDARIDAD.- It is a project based on the new Mexican Solidaridad satellites, owned and operated by the Mexican Federal Government. It will have C, Ku and L band capabilities on each of the two GEO type satellites. The L band segment of the Solidaridad satellites will cover Mexico and its territorial waters only (6). This will allow mobile satellite communications services, to be commercialized by one or two independent operators. The Solidaridad system is expected to be fully compatible to the MSAT system in most technical and operational aspects. Since Solidaridad and MSAT's coverage regions overlap, long negotiations on available spectrum and intersatellite interference were held, with INMARSAT also included in the process. The Solidaridad mobile services are expected to be offered in the second half of 1994. Since the technical aspects of the system will be similar to those of the MSAT system, its mobile terminals and general ground infrastructure also could be very similar (7). Its fixed-site mobile service is being considered for rural telephony applications, depending upon the service costs and available bandwidth.

4.2 LOW EARTH ORBIT SATELLITES (LEOS).

As its name implies, LEOS follow a different orbit than GEOS do, orbiting the Earth at a lower height. This type of orbit requires that the satellite travels at a higher rotational speed than that of the Earth. For that reason, LEOS appear on the horizon, pass by and disappear again in a matter of minutes or hours, depending upon the orbit. The usual orbits of LEOS are found between 500 and 2,000 km of height. Since one single LEO satellite cannot give reliable communications service for long periods of time, more than one satellite is required. Besides, in order to give complete global coverage many orbital planes are needed. For that reason, LEO systems generally require a large number of satellites, called "constellations," offering a continuous communication relay service. Some of the main advantages of LEOS are the almost non existent delay and the low propagation losses. Its disadvantages would be the complexity of the communications relay issue, the many spacecrafts' traffic control, and the doppler effects.

IRIDIUM.- It is a communications' system based on the use of 66 LEO satellites, with global coverage including the Earth's poles. It is being developed by Motorola (U.S.A.) and it is expected to be available to the public between 1996 and 1998. It will have 11 LEO satellites per plane in 6 different orbital planes, able to serve terrestrial users at L band frequencies. IRIDIUM also will have intersatellite links and feeder ground station links both at Ka band (30/20 GHz). The services offered will include voice, data, facsimile and paging, in user terminals similar to current pocket-sized cellular phones. For its IRIDIUM system, Motorola applied for the lower part of the mobile L-band spectrum (1610-1625 MHz). IRIDIUM expects to bring wireless telephone to the entire world, and since the satellites work on a cellular spot beam architecture, it can reuse frequency much easier and more frequently than GEOS do (8).

GLOBALSTAR.- It is a LEO satellite system developed by Loral Qualcomm (U.S.A.), that will be compatible with current and future PSTN and cellular systems. It will consist of 48 LEOS that provide global coverage for wireless mobile service for voice and data, paging, messaging and radio determination satellite service (RDSS) (9). It will require a mobile terminal consisting on a vehicle-mounted unit, a handheld unit and a RDSS unit. One interesting aspect about GLOBALSTAR is that it will use CDMA technology, which does not require frequency coordination from other systems. It will use L band uplink and S band downlink with circular polarization for the mobile-satellite link, and C band for the satellite to gateway station feeder link. GLOBALSTAR also can reuse frequency easily, and it is expected to be deployed by 1997.

CALLING.- The CALLING Network is among the latest newcomers to the LEO satellite crowd. What makes CALLING an interesting system is its size (840 satellites), its technology (broadband digital communications), its drive (service to developing as well as industrialized countries), and its vision (a global telephone utility). Presented by the Calling Communications Corporation (U.S.A.), the CALLING Network intends a quantum leap in mobile satellite technology. Its objective is to bring modern wireless urban communications services, costs and availability to the entire world. To do this, it will require over 200 MHz of bandwidth, only available at Ka band (30/20 GHz), reusing its frequencies over 20,000 times on a global basis (10). It also would carry all telephone traffic over the country's local telephone company, sharing the service fees both satellite and terrestrial service providers. The CALLING system is designed to provide service to both fixed-site and mobile terminals for services up to multirate ISDN or DS-3 rates (about 44 Mbps). The network uses fast packet switching technology, similar to that of ATM now developed for LAN, WAN and Broadband ISDN networks. Each of the 840 satellites is a node in the fast packet switch network, and has up to 8 intersatellite links in the same orbital plane. Fixed and mobile user terminals will be similar to current cellular terminals, and the gateway interfaces will comply with international digital standards. The CALLING Network is expected to be available by 1998 .

From all the systems described above, it can be seen that mobile satellite communications are growing at an incredible rate. There are many different technologies, all of them attractive, but it is important to use them fairly and wisely, not just profitably.

5. RURAL TELEPHONY BY SATELLITE.

The application of rural telephony by satellite has been widely studied and described, but in fact much of that work never crystalized. There are a few places where it has worked, but mainly in conjunction with other technologies. Rural satellite telephone networks usually consists on less than 50 terminals, and generally have other multiplex systems to cover the last mile.

There are some countries in Africa (Nigeria, Sudan) and the Middle East (Saudi Arabia) that were early users of satellite for rural applications (11). Latin American countries like Mexico (12) also have used satellite technology to bring telephone to rural areas. As for Asian and Pacific countries, both Indonesia and India have a rural presence in their satellite systems. These telephone networks have been financed mainly by their national Governments, and generally involve different size VSAT terminals on domestic, regional or international GEO satellites. INTELSAT also offers its VISTA and Super VISTA networks for analog and digital voice transmission, and its C band global spots guarantee telephone access from any remote place in the world.

5.1 MEXICO'S EXPERIENCE.

Mexico is a highly mountainous country with all kinds of environments (from deserts to jungles) and a territorial area that spans from North to Central America. Its population in 1990 was of 81.1 millions, with over 33% living in rural areas, most of them in villages of less than 500 inhabitants. 12% of the population lives in 90% of the total communities of the country, averaging 70 inhabitants per location. In order to grow, Mexico has to bring communications to these communities, and help its development. Having two Mexican domestic satellites already, rural telephony by satellite seemed an interesting possibility to some federal and local state authorities, and some pilot programs have arised in the last few years.

Currently there are three rural satellite systems in Mexico, serving a different area of the country each on the Mexican Morelos satellites. Two of them were financed jointly by the federal government and the local governments of two states (Sonora and Oaxaca). The third is part of a regional public telephone network (TELNOR), as part of its regional coverage plans. These systems are completely different from each other in almost every aspect. They use different access technique to the satellite, different data rates, different frequency bands and a different approach to the last-mile problem (Table I) (12).

5.2 LAST MILE TECHNOLOGY.

In rural telephony, many things can be done in the last mile (access to users from the telephone earth terminal) when using VSAT-like earth stations. One of the most preferred and widely used topology is the tree-branch distribution [Fig. 2]. If the satellite link is viewed as a trunk-type gateway access to PSTN, then a Private Branch Exchange (PBX) can give extra local service at the remote terminal location. With many satellite links on a star configuration, the number of covered users is multiplied by the potential circuit-calls. Usually, the last-mile links use HF or VHF multiple access radios, but there is an increasing number of cellular users coming out.

Long Distance Rural Telephony Transmission Systems:
- Coaxial Cable.
- Fiber Optics.
- VHF and UHF Radio
- Microwave Radio.
- Fixed Satellite.
- Mobile Satellite.

Last-Mile Rural Telephony Transmission Systems:
- Twisted Pair Wire.
- Coaxial Cable.
- HF and VHF Radio.
- Cellular Phone.
- Mobile Satellite.

TABLE I.- GENERAL COMPARISION OF MEXICAN RURAL SATELLITE NETWORKS.

	SONORA		OAXACA		BAJACALIF.	
CHARACTERISTICS	MASTER	REMOTES	MASTER	REMOTES	MASTER	REMOTES
# Earth Stations	1	15	1	10	1	9
Frequency Band	C	C	C	C	Ku	Ku
Data Rate	64 Kbps	64 Kbps	256 Kbps	192 Kbps	64 Kbps	64 Kbps
Satellite Access	SCPC	SCPC	TDM	TDMA	AA-TDMA	AA-TDMA
Antenna Diameter	7.5 m	3.2 m	4.5 m	3.4 m	5.5 m	2.4 m
HPA Power	125 W	4 W	10 W	4 W	500 W	3 W

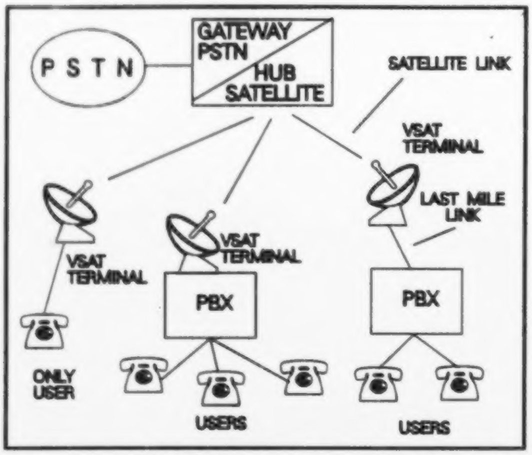

FIGURE 2. TREE BRANCH DISTRIBUTION FOR RURAL SATELLITE TELEPHONY

From the above list, it can be seen that Mobile Satellite is a fitting option in both long distance and last-mile applications. That can be done with any semifixed or land mobile terminal.

VSAT Satellite Links: There are many advantages with this popular scheme, but its efficiency depends upon the number of terminals, local and satellite traffic, the last-mile's and satellite's multiple access technique, and the available satellite bandwidth. The main disadvantage is the remote terminal's price (over 25,000 US Dlls) which, multiplied by the number of terminals required in a rural network, inhibits its use by a developing country. The network technology also is important in the aspect of bandwidth efficiency and system complexity [Table II].

MOBILE Satellite Links: So far, only INMARSAT has the capability to offer telephone communications to a mobile user on a global basis, and Australia is just beginning on a local basis. Currently INMARSAT offers

TABLE II.- COMPARISION OF DIFFERENT SATELLITE TECHNOLOGIES FOR VOICE APPLICATIONS.

	FIXED SCPC	SCPC DAMA	TDMA	SS-CDMA	MOBILE GEO	MOBILE LEO
System Complexity	Very Low	Low	High	Regular	Low	Very High
Bandwith Efficiency	Very Low	Very High	High	High	High	Very High
# Remote Terminals	Low	High	Very High	Very High	High	Very High
Bandwidth Required	Depends	Low	Depends	Very High	Low	Low
Overall System Cost	Low	Regular	Very High	High	Regular	Very High
Available Topology	Point to point, Star	Point to point, Star	Star, Mesh	Star, Mesh	Star	Star, Mesh

A, B and M terminals for voice applications, but the A and B services are aimed at the maritime market. For that reason the mobile terminals' costs are very high ($50,000 US for the A terminal and expected $35,000 US for the B terminal), which leaves out low cost applications. For rural and land mobile applications, only the INMARSAT M service will compete with other networks (13). The INMARSAT M user terminal's cost is expected at around 25,000 US in the beginning, and $5.50 US per minute service (14). Australia's Mobilesat is expected to offer service with lower price terminals at A$7,000 (Australian Dlls) and A$1.50 per minute service cost (15). Figures on LEOS systems are still so unpredictable that are not mentioned here.

6. RURAL TELEPHONY NETWORK PLANNING AND IMPLEMENTATION

There are many differences on the individual characteristics of each nation, which makes it very hard to try to implant the same design of a rural telephony network everywhere. These differences can be based and divided into two main areas: geopolitical and technical.

The geopolitical area depends upon the specific characteristics of each country. Every country in the world is different from each other, based upon its history, geography, education and social system. Among the geopolitical aspects, we can find:

- the country's size, geography and terrain topology,
- the country's political system history,
- the country's products and economy,
- the country's rural population,
- the country's existing communications infrastructure (roads and telecommunications).

The technical aspects are somehow easier to confront, since they are based on standards and on the availability of new technology to the developing country. Among the technical aspects we can find:

- the country's existing telecommunications regulations,
- the real enforcement of those regulations,
- the country's infrastructure standards and its compatibility to international standards,
- the open availability of telecommunications technology from industrialized countries,
- the country's PTT quality of service,
- the country's current and future telephone traffic,
- the country's existing engineering workforce and technical education schools.

The aspects above mentioned influence deeply the importance of rural communications on each country. The differences between each developing country make it more difficult to consider a general average basis.

There are some common aspects, though, and those can be used to develop a common strategy, somehow independent from the geopolitical factors:

- Existence of small, remote communities, far from urban centers.
- Low telephone traffic in local and long distance calls.
- Difficult access to electrical power lines.
- Difficult access on terrestrial vehicles.
- Scarce supply of trained technical personnel.
- Rough weather and extreme variety of climates.
- Low educational level of potential users.

Based on the above information, the main specifications of a explicit national or regional rural network can be specified. The most important aspects from the network point of view are:

- The number of satellite remote terminals.
- The number of last-mile nodes served per terminal.
- The network's capability for future growth.
- The total number of served rural nodes.
- The expected satellite telephone traffic.
- The expected local telephone traffic.
- The grade of service required in each case.

On the other side, there are some important matters to be considered from the satellite's point of view:

- The system's capability to deliver toll quality telephony.
- The satellite's full coverage area.
- The satellite's EIRP and G/T figures from the contours.
- The remote terminal's EIRP and G/T figures.
- The size and portability of the remote terminal.
- The satellite link's multiple access and protocols.
- The required and available satellite bandwidth.
- The overall cost of the system for the operator and user.

As mentioned throughout this article, there is not a "recipe" to design a satellite rural telephony network, and many aspects must be considered. This article only intends to give another point of view in order to meet this challenge.

7. FUTURE INTERACTION OF EMERGING TECHNOLOGIES ON RURAL APPLICATIONS.

As mentioned before, there is a number of proven technologies for rural telephony applications, such as multiplex radio, cellular, and satellite. Nevertheless, there are new variations of the above systems, which can bring out new sets of combinations, more reliable and efficient. These new technologies, and its potential applications, have rised great interest in national and international institutions. The Organization of American States (OAS) has worked closely with the Mexican Government in a project called "New Communications Technologies applied to Social Interest Zones" for Latin American countries (16). It describes some emerging communications technologies, and it develops the methodology to apply them to rural and low income urban applications. Besides the new technologies mentioned in such study, other systems will soon appear to change the face of rural communications before the new millennium. So far, it is easy to foresee the most talked about technologies, and we are looking for new solutions to old problems. Such technologies are:

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- Spread Spectrum Radio.
- Digital Cellular Systems.
- Terrestrial Personal Communications Systems.
- VSAT Satellite Systems.
- GEO Mobile Satellite Systems.
- LEO Mobile Satellite Systems.
- Wide Band Wireless Digital Communications.

It can be noticed that all the systems mentioned above are wireless. That is, they use the radio spectrum for communications, without the need of wires, cables or fibers. This does not mean wires and cables will disappear, but rather that they will continue to be absent in the rural scenario due to its limited coverage. In fact, cabled systems, specially fiber optics, will get stronger in urban and high volume traffic applications. Cabled and radio systems will continue to interact and complement each other for a long time, still. There is already an open discussion about the future of the radio spectrum, and new, bold proposals are being considered for its efficient exploitation. Radio systems are preferred on the rural environment basically for its good area coverage.

Regarding mobile satellite communications, there are good prospects of its use on rural communications through both GEO and LEO systems. Depending upon the application and the specific characteristics of the area to serve, satellite communications will surely require terrestrial communications technology. Based on the emerging technologies mentioned above, new topologies and combinations will breed new services and applications. In order to make the best use of them, it is necessary to understand the technical, financial and social aspects of each application.

8. SUMMARY AND CONCLUSION.

The general aspects of current rural communications in developing countries is presented in this article. One of the most attractive new technologies available are the possibility of using mobile satellite communications. Among its advantages are its portability and global area coverage. Though there is currently only one such global provider, there are some countries in advanced stages of development of domestic mobile satellite systems. These systems will offer, among other services, remote telephone access to the PSTN. The possibility of using mobile satellite technology for rural telephony applications is discussed, describing different available or proposed systems. Mobile satellite systems can be divided into LEO or GEO sistems, based upon its orbit around the Earth. Each system has different parameters, advantages and disdvantages, and a discussion on that is presented. One of the most difficult problems mentioned is the distribution of radio frequency spectrum for mobile and wireless applications. The general situation of rural telephony by satellite is explained, mentioning Mexico's experience in this area. The principal aspects to consider in the design of a satellite rural telephony network are described, and the future interaction of existing systems with newly emerging technology is explained. The final idea is to suggest new ways to bring communications to rural communities through new satellite technology.

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PEACESAT: A REGIONAL TELECOMMUNICATIONS ALLIANCE IN TRANSITION

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1. ABSTRACT

The **P**an-Pacific **E**ducation **and** **C**ommunications **E**xperiments by **Sat**ellite (PEACESAT) Program, sponsored by the U.S. Congress and the Department of Commerce's National Telecommunications and Information Administration (NTIA), was re-established in 1989 through the use of the National Oceanic and Atmospheric Administration's (NOAA) GOES-3 satellite. Since its formal opening in 1992, the PEACESAT regional telecommunications alliance has grown to 36 sites in 25 countries.

The objectives of this paper are to provide a brief overview of the program, review some of its current challenges, and describe how the PEACESAT program is preparing to meet these challenges. The paper describes PEACESAT's plan to meet the needs of users in the short and intermediate-term. The plan calls for PEACESAT to optimize the use of the GOES-3 capacity by increasing the number of analog carriers, establishing a digital carrier network, applying technologies that optimize the use of full duplex channels for concurrent voice and data communication, and to establish multiple video teleconferencing channels. PEACESAT's plan will constitute a major transition of the telecommunications alliance.

2. BACKGROUND

The PEACESAT program was initiated in 1971 to experiment with distance learning, emergency information, and teleconferencing applications through the use of a single push-to-talk voice communication using the ATS-1 satellite by sites in the Pacific.[1] In 1985, the PEACESAT program became temporarily limited when the ATS-1 satellite ran out of fuel and could no longer support the needs of its users.[2] The program was re-established by the United States Congress through the efforts of Senator Daniel Inouye of Hawaii, NTIA, users, and the University of Hawaii.[3] The missions, re-establishment, use, and potential of PEACESAT are discussed in several documents and reports and are not described in this paper.[4]

The re-establishment was made possible through repositioning of the National Oceanic and Atmospheric Administration's (NOAA) geostationary weather satellite, GOES-3, in 1990. GOES-3 was one of a series of satellites used by NOAA for weather data gathering.[5] Through the repositioning of the satellite, the GOES-3 footprint covers parts of the West Coast of the USA, most of the Pacific Rim, and all of the Western and South Pacific Islands countries.

Since the PEACESAT program was formally re-established in 1992, the growth of the network has been tremendous. As of November, 1993, 36 sites in 25 countries have acquired terminal equipment (antenna, power, transceivers) to access voice and data services throughout the Pacific. There are also 20 additional sites that have committed to come on-line in the Federal Fiscal Year 1993/1994 (October 1, 1993 to September 30, 1994).[6] In addition, more sites are considering becoming part of the PEACESAT network.

2.1 Challenges

The re-establishment of PEACESAT has occurred smoothly and the program is providing services as planned and designed. PEACESAT has also received enthusiastic support from its users in the Pacific.

At the same time that the re-establishment may be viewed as a success, PEACESAT faces several challenges. One challenge centers around how PEACESAT will meet the increased demands by users for more full duplex data access, concurrent voice/data services, and video teleconferencing based educational services. A second challenge is how PEACESAT should maintain, strengthen, and extend services in the short- and intermediate-terms. A third challenge for PEACESAT is the selection of a long-term satellite solution that can support the needs of PEACESAT.

2.1.1 Level of Services and User Demands

One of the pressing challenges for PEACESAT is the level of services that are provided through the GOES-3 satellite system. Island governments, educational institutions, regional organizations, and other users have made their needs known to NTIA and PEACESAT. In the near-term, PEACESAT users desire access to increased data channels and are requesting concurrent access to dedicated data channels. Some users also are requesting concurrent voice, data, and compressed digital video. Over the long-term, PEACESAT users desire high-speed data networking and full-motion video.

2.1.2 Short- and Intermediate-Term Solutions

Until a long-term solution is developed, there is a need to meet the needs of users during the short and intermediate terms. This challenge is directly addressed in this paper and may be achieved by optimizing the use of the existing GOES-3 satellite. This approach is consistent with NTIA's recommendation issued in a 1992 report which states that: "NTIA should work toward extending PEACESAT's use of the GOES series of satellites to provide more time to search for the long-term satellite configurations [to meet the needs of users]."[7]

2.1.3 Selection of a Satellite for Future Programming

The selection of a satellite to provide long-term services is important for two reasons. First, the agreement between NTIA and NOAA to use GOES-3 will end in 1995 even though there are indications that the agreement will be extended for the life of the satellite. Second, and just as important, the GOES-3 satellite will probably run out of fuel sometime around the Year 2000 and is expected to have problems in maintaining its geostationary orbit. Finally, there are inherent limitations in the capacity of the GOES-3 system to meet the growing needs of its users.

In response to this challenge, NTIA and PEACESAT have initiated studies to define user needs and alternatives for providing a long-term satellite system for PEACESAT. The selection of an alternative satellite to deliver the services is critical to the long-term success of the PEACESAT program. The studies by NTIA and PEACESAT have been documented most recently in a December, 1992 report issued by NTIA entitled PEACESAT: Communications Satellite Services for the Pacific Islands: Satellite Feasibility Study.[8] Although the report does not contain recommendations for a long-term solution, progress toward analyzing alternatives has been made.

2.2 NTIA and PEACESAT Assessments of User Needs

NTIA and PEACESAT have been continuously working toward identifying and defining the needs of users. This is always a critical but difficult task. Identifying requirements is important since they impact the definition of alternative solutions. At the same time, defining user requirements is difficult since users' needs are dynamic and change with experience, environmental factors including budgets, and developments in technology. The NTIA and PEACESAT reports describe some of the user requirements in the near- and long-term future (2007) and include:

- Increased data circuits for Internet and other data driven information services;
- Concurrent voice and multiple data access support;
- Channels for sensitive voice and data communication;
- 64 Kbps transmission for higher speed data transfer;
- Compressed video teleconferencing;
- High-speed data communication; and,
- Full motion video.

Based on the report and response from users, the long-term needs for improved communication services to the Pacific will require significant communication capability, and some requirements such as full-motion video may never be able to be delivered through a PEACESAT type program, with the exception, perhaps, of public broadcasting video. These general needs will be further studied to determine their relative importance.

In the short- and intermediate-terms, it is clear that PEACESAT needs to provide concurrent voice and data services, and support concurrent data access services for information access.

Since introducing data services, the needs and demands for data access have grown steadily. The anticipation over the introduction of INTERNET services and other planned data-driven information programming (BBS) has been overwhelming. PEACESAT needs to improve access to the high-volume usage areas. It is hoped that these users will be able to access data-driven information services on an ongoing basis without operator assisted circuit switching that in itself does not optimize data transmission.

Any user of Internet or other on-line information services knows the problems of trying to schedule time for the use of such circuits. A reservation system may be initially acceptable, but it will not be acceptable for long, especially when the service is shared by 35 different sites. The contention for the use of the channel has already resulted in conflicts between and among voice and data users. The conflicts are expected to grow.

More and higher speed digital channels are also needed since compressed digital video transmission may be important to the overall development of the PEACESAT program given its current mission (e.g. telemedicine applications and distance education). It may become even more important as PEACESAT provides support for the promotion of regional economic development activities.

2.3 PEACESAT Program Priorities

PEACESAT, as with any other program must prioritize where it will concentrate its resources. Any PEACESAT program activity must be guided by a set of priorities. NTIA suggests the following priority scheme for PEACESAT to use in its program planning:

1. Maintain existing services;
2. Strengthen existing services;
3. Make existing services more widely available (both to current users and new users); and,
4. Develop new services.[9]

The priority scheme implies that PEACESAT plans to improve services in a way that maintains the existing services, strengthens them, and increases their availability to the Pacific Basin and Rim before introducing new services. The priorities are reasonable given limited budget and satellite resources.

3. OPTIMIZING USE OF GOES-3 FOR THE SHORT- AND INTERMEDIATE-TERMS

Until a long-term satellite solution is found to meet the needs of the Pacific Basin and Rim, GOES-3 could be used to provide improved voice, data, and compressed video service for the short- and intermediate-terms.

The PEACESAT/GOES-3 transponder operates in S and L Bands and has an 8 MHz bandwidth (2025-2033 MHz Transmit and 1683-1691 MHz Receive). The current voice and low-speed data carriers are 16 KHz and are spaced 50 KHz apart. A full duplex channel uses two of these carriers.

The capacity of the GOES-3 transponder is not being fully utilized. There is additional carrier and bandwidth capacity that could potentially be used by PEACESAT to meet the needs of users in the short- and intermediate-terms. There are also technologies that may be used to optimize the use of the carriers. The following is a brief discussion of how these opportunities could be realized by PEACESAT.

3.1 Increasing Number, Type, and Capacity of GOES-3 Carriers

PEACESAT could increase the number, type, and capacity of GOES-3 carriers.

3.1.1 Increase the Number of Analog Carriers

PEACESAT could increase services to meet the demands of users by increasing the number of analog carriers and to increase the accessibility to these carriers by remote sites.

The current design of the PEACESAT mesh network means that users can only transmit a single carrier that can support either a simplex voice or a full duplex voice/low speed (9.6 Kbps) data link. The design allows Pacific Island and Rim sites to communicate with each other through 9 existing simplex carrier circuits and 3 full duplex carrier circuits. The full duplex carriers support low-speed (9.6 Kbps) data.

The design provides the benefits of internetworking many different locations throughout the Pacific using a minimum number of carriers. The downside of the system are that: (1) the carriers only support a single use, (2) 35 PEACESAT sites must share only 3 full duplex circuits, and (3) PEACESAT Headquarters (PHQ) currently only has 1 transceiver that can be used for data purposes. To improve access to more GOES-3 full duplex carriers, PEACESAT could modify the terminals to access new analog transmit/receive carrier frequencies.

3.1.2 Increasing the Number of Concurrent Carriers at PEACESAT Headquarters (PHQ)

Increasing the number of analog carriers that can be used by PEACESAT sites will not by itself resolve the problem of concurrent data access to PEACESAT Headquarters. The use of the current 3-Meter antenna and power amplifier inherently limits the number of carriers that can be handled by PHQ. These antennas and power amplifiers were designed to support a single analog carrier.

Since PHQ has two antennas, it can currently have two simultaneous sessions. However, if PHQ has a voice conference and data session established, it will not be able to provide any hub administrative services such as contacting users of impending meetings.

PEACESAT could increase the number of carriers that PHQ can receive and transmit in order to provide

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concurrent access to multiple voice and data channels.

There are two alternatives by which this could be accomplished. First, PEACESAT could install a new terminal (antenna, power amplifier, indoor electronics) for each channel that PEACESAT wants to establish. This would create an antenna farm and is not very practical given the space and cost factors. Second, PEACESAT could upgrade the size of one of its existing antennas, purchase a new power amplifier, and install a rack mounted GOES-3 transceiver channel bank to save space and power. Increasing the size of the antenna, power amplifier, and installing a transceiver bank clearly appears the better solution when compared to installing an antenna farm.

3.1.3 Establishing a Digital Carrier Network

Increasing the number of analog carriers and increasing the capability of PHQ to concurrently support multiple carriers will not solve the needs of certain sites to transmit voice and data simultaneously.

To resolve these problems, PEACESAT could establish a digital carrier network concurrent with the existing analog FM network to increase the capacity to support multiple voice, data, and compressed video channels by sites. By creating a digital carrier network, PEACESAT may be able to support the simultaneous transmission of voice, data, and possibly compressed video communications. Digital carriers are generally favored over analog FM modulation since it is more cost-effective in the use of satellite resources.

Naturally, there are limitations to the number and capacity of digital carriers that can be established. The limitations will depend largely on the power budget, bandwidth, capability of the satellite transponder, and potential impact on the analog carriers.

3.1.4 Compressed Video Mesh Network Carriers

Digital carriers capable of supporting 64+ Kbps could be established to support compressed digital video applications. It may be possible to design the use of the carrier capacity of the GOES-3 to support a single digital carrier with a data rate of up to 768 Kbps. The question is what data rates should PEACESAT support for compressed video teleconferencing given the other needs for voice/data.

3.1.5 Planning Model for PEACESAT

Table 1: Capacity Planning Model shows the number and capacity of various carriers that could potentially be established using the 8 MHz bandwidth of the GOES-3 satellite. The table presumes that there is about 1 to 1.5 Mbps of digital capacity available for use. This is equal to about 768 Kbps in full duplex mode.

Table 1: Capacity Planning Model

Carrier Type	Quantity
Analog FM	**Existing** 9 Analog Simplex for Voice and 3 Analog Full duplex for Voice/Data
Analog FM	**Potential New** 10 Analog Simplex for Voice or 5 Analog Full duplex for Voice/Data
Voice/Data Digital RF	**Potential New** 8 to 16 -- 32 Kbps FD Channels
Digital Video Digital RF	**Potential New** 2 -- 128+ Kbps FD Channels

The planning model shows GOES-3 potentially supporting about 10 new analog FM carriers and 16 digital carriers with 32 Kbps capacity. The model also shows GOES-3 supporting 2 new digital carriers that have 64/128+ Kbps in carrier capacity for compressed video or higher speed data transfers. If these capacities can be realized, then, GOES-3 could potentially strengthen existing services and make them more widely available to meet the needs of the Pacific Islands and Rim. The extent to which GOES-3 can meet these needs will be subject to philosophy, technical system constraints, design, and costs.

Digital bandwidth tests on GOES-3 have been conducted by MAS with 64 Kbps channels. The success of the tests show that higher bandwidth carriers could be established and supported using the existing 3-Meter antennas and 50W power amplifiers.[10] However, the planning model is theoretical and the real questions remain:

- How many concurrent analog and digital carriers can be supported for enhanced services?
- What digital data rates can the digital carriers support?
- How can these carriers best be used?

3.2 Optimization of Carrier Capacity

Presuming that a digital carrier system can be established using the GOES-3 satellite, there are several technologies that could be used to optimize the voice, data, and compressed video communication over the digital carrier. The optimization may be realized by using voice compression, data concentrators, and a Digital Bandwidth Manager (DBM) that supports different digital transmission schemes such as circuit, packet, and frame relay over digital channel capacities less than 256 Kbps.

3.2.1 Voice Compression

Voice can be converted into digital data through pulse code modulation that can then be "compressed" through bit sampling algorithms. The "compressed voice" is then communicated as digital data streams from one site to another. When decompressed, the data is converted back into audio voice signals.

Today, some vendors have acceptable quality voice carried over a CELP bit sampling algorithm requiring 4.8 Kbps of transmission. By compressing the voice to lower bit rates, it is possible to carry more voice channels on a carrier. For example, a single full duplex digital circuit capable of supporting 9.6 Kbps can provide 2 voice circuits at 4.8 Kbps, assuming that bandwidth is used for in-band signaling.

3.2.2 Data Concentration

The current use of a 9.6 data channel over a full duplex analog carrier by a single user is not an efficient use of the GOES-3 resource. To make better use of the available bandwidth, data multiplexing technologies could be used to share resources among more users. X.25 packet data switching could be effectively deployed by PEACESAT to enable more users to share full duplex data channels for access to on-line and Internet services.

Response time and throughput in an X.25 network is dependent on the number of concurrent users and best applied in an on-line data access environment where users interact with host system(s). X.25 is not optimized for bursty data and large data file transfers.

Response time should not be a problem for many PEACESAT sites that are limited through the "land line" connections to lower speeds. Response time could become a problem for users with good telecommunication local land lines and are doing large data file transfers.

3.2.3 Voice and Data Multiplexing

Since both data and voice can be compressed as digital data, it is possible to use a single digital transmission carrier to carry multiple channels of digital voice and data traffic. The capacity of the transmission facility, level of voice and data compression, nature of application, and quality of voice acceptable will determine the usefulness of a transmission facility for a particular application.

To optimize the use of a digital channel, PEACESAT could use a Digital Bandwidth Manager (DBM) to transmit simultaneously compressed voice and X.25 packet switched data. Using technologies that are commercially available, it is possible to share a 19.2 Kbps digital channel to support 2 voice (at 4.8 Kbps) and multiple data users concentrated through X.25 packet switch through a DBM.

This basic approach is well established through many different vendor technologies and allows further optimization of voice and data communications over scarce PEACESAT carrier resources. Some vendor systems can take multiple analog voice inputs, digitize the signals, and apply a compression algorithm for the voice and concentrate data transmissions. This enables, depending on the voice and data compression algorithm, the systems to transmit multiple concurrent voice sessions over a 14.4 Kbps and higher full duplex channel.

These systems can further route the voice as circuit data and packetized X.25 data to the destination. The routing for data is dynamic. Depending on the capacity of the full duplex channel and the level of technology that is deployed, the routing of the voice traffic can be done dynamically or through an external switch.

3.2.4 Video Compression and Higher-Speed Data Channels

Once a higher-speed digital carrier is established, it can be used to support compressed video and higher speed data file transfer applications.

The DBM could also be used for routing of nx64 Kbps data. Support for fractional T-1 services is important for higher-speed data file transfers and for compressed video. The CCITT has developed standards for video transmissions based on "px64" digital data rates.

Sites that may have more than one location that need to be inter-networked for compressed video would be served best through a single communications technology that can redirect the signal to multiple interface channels. A PEACESAT site, for example, might have a need to establish a video conference session with another local site through a microwave network as well as through the PEACESAT network. A DBM with the ability to route the px64 video codec traffic from one channel interface to another would be useful and minimize the amount of manual rewiring that may need to be undertaken.

4. GOES-3 SERVICES IMPROVEMENT PLAN

PEACESAT has proposed a GOES-3 Services Improvement Plan (SIP) to NTIA. The plan calls for PEACESAT to: **11**

- Maintain 9 current carriers for command, voice mesh network and 3 full duplex channels for data applications (The number of analog carriers may be reduced and replaced with mesh network digital data carriers);

- Establish a digital network hub that can support concurrent voice and data uses between a minimum of 10 sites in the Pacific and PEACESAT Headquarters;
- Introduce integrated voice, data, and 64+ Kbps digital bandwidth managers to optimize the voice, data, and compressed video communication uses enabled by the digital carriers;
- Establish a voice bridge between mesh network and digital network carriers for voice communications; and,
- Establish multiple digital carriers capable of supporting a minimum of 64 Kbps for compressed video applications.

From a program perspective, the PEACESAT design maintains existing services, strengthens existing services by improving their operation (e.g. concurrent voice/data and concurrent data access from sites), and makes the services more widely available to PEACESAT users by providing concurrent access to more users at sites. The design also enables more sites to become part of the mesh network may be internetworked with other systems and networks throughout the Pacific Basin and Rim such as the Japanese ETS-V and the State of Hawaii's HAwaii Wide Area Integrated Information Access Network (HAWAIIAN).

From a technical perspective, the design is based on the strategy of supporting and enhancing the existing analog services network while taking advantage of the capacity of the GOES-3 satellite through establishing a digital data network with a hub at PHQ. The design also includes a capacity for new services such as compressed digital video teleconferencing in a cost-effective mesh network design.

5. IMPLEMENTATION PHASES

The overall project plan calls for PEACESAT, NTIA, AND MAS to:

1. Develop GOES-3 Services Improvement Plan
2. Develop PEACESAT Partners and Participants
3. Install an 8.5-Meter Antenna (Power amplifier, etc.) at PHQ
4. Install a Transceiver Bank and Testing of 19.2 Kbps Analog or 32 Kbps Phased Shift Modems
5. Operationalize Data Services
6. Install a 6-Meter Dish at MAS
7. Conduct Satellite Transmission Tests
8. Install Digital Bandwidth Managers
9. Conduct Voice, Data, and Compressed Video Tests
10. Develop GOES-3 Services Deployment Plan (Including Frequency Allocation)
11. Deploy the Network

The implementation of these tasks could be accomplished in three phases. Phase I would increase the number of full duplex carriers that can be simultaneously received at the PEACESAT hub and for testing the capacity and the ability of the 19.2/32 Kbps full duplex carriers to handle multiple channels of concurrent voice and data over limited bandwidth.

Phase II would focus on the experimentation and testing of the various transmission resources of GOES-3 and to test the ability of the terminals to support voice, data, and compressed digital video at various capacities.

Phase III would focus on the deployment of the services based on the results of Phase II.

6. IMPLICATIONS

There are several implications that will arise from the conceptual design of the GOES-3 SIP. These implications need to be considered in the final design and implementation of the plan.

6.1 User Groups

Establishing a digital or star network design to complement the existing PEACESAT mesh network will create two basic types of "users." One group of users will use the analog "mesh" network. A second group of users will be linked to the PHQ in a digital star or hub and spoke network. All sites using the digital services will have multiple concurrent voice and data services and be internetworked to the mesh users through bridging at PHQ.

The creation of different "user groups" may create an impression that there are different "classes" of users in PEACESAT. The concept of "classes" may be viewed from at least two perspectives. On the one hand, it could be viewed as detrimental to the concept of PEACESAT, which has historically stressed a system that provides the same capabilities equally to its user community. On the other hand, the plan may be viewed as a means of meeting the needs of different users. It should be understood that users will select which user group the site will participate in.

constrained, of course, by the number and capacity of digital carriers that can be provided through GOES-3.

6.2 Cost of Network

There are cost implications of the proposed network for both the PHQ and user sites. PHQ would need to install a larger antenna and power amplifier, additional analog and digital transceivers and RF modems, a bridge to interface the analog and digital channels, and the additional networking capacity to access other systems and networks in Hawaii which users wish access to (e.g. UH libraries system). PEACESAT would also need personnel and space to support the technology upgrades.

PEACESAT sites, depending on the tests, will not need to upgrade their antennas or power amplifiers for single 32 or 64 Kbps channels. These sites would need to acquire a voice/data DBM and the additional peripherals to support multiple concurrent voice and data applications.

However, if a site requires use of higher-speed video channels beyond 64 Kbps or concurrent voice and data with a 64 Kbps video link, then, the site will incur additional costs. The major costs that will be incurred by a site will be for a larger antenna, power amplifier, and a voice bridge if one is not already present. There will also be costs for interfacing the systems to local public service telephone network.

6.3 Technical

There are several technical issues that will need to be resolved. The major technical issue is the number of digital carriers and capacity that can be established without interrupting or degrading the existing mesh network analog carriers. Other issues include the design of the terminals to support two digital and one analog carriers, level of interference with analog FM carriers, how the mesh and star network voice services would be bridged through the network, and whether the DBMs will function the way it is currently projected over a satellite carrier. None of the issues are significant enough to invalidate the conceptual design of the GOES-3 SIP. The major technical concerns revolve around the ultimate capacity of the carriers and design alternatives.

These concerns will be addressed in the Phase III GOES-3 Services Deployment Plan that would be prepared at the conclusion of the tests conducted in Phase II.

The technical issue of how the "mesh network" user would interface to "digital" users is one issue that merits some discussion here since a major program objective is to enable sites to communicate with each other. PEACESAT would need to bridge the analog mesh network communications carrier channels with the digital voice carrier channel though either a voice bridge or voice switch that supports voice conferencing. The optimal solution will depend on PHQ's other local telephone, data, and video teleconferencing bridging requirements.

6.4 Operational Implications

There are operational implications that will also need to be considered by PEACESAT. From a systems point of view, some of the operational implications will include: network management functions; bridging mesh with star network voice; developing new scheduling systems for compressed video programming; bridging pass-through communications between Hawaii video conference and HITS studios to the network, and so on. There will be a measure of added complexity for the PHQ since the technology that is being implemented is far more complex than the technology being used today.

7. SUMMARY

The re-establishment of PEACESAT has been successful. However, there is a need to extend and strengthen services to the Pacific. The services requested by current PEACESAT users include more voice and data channels, concurrent voice and data communications, non-interrupted data services, higher bandwidth data, and compressed video. Most important of these services in the short-term is to provide concurrent voice and data access.

Although NTIA and PEACESAT are studying the long-term solution, there are short- and intermediate-term steps that could be taken to improve services. PEACESAT has developed a plan to provide more analog carriers, establish a digital carrier network using the additional bandwidth capacity, and optimize the use of the digital carriers through multiple access digital telecommunication technologies.

PEACESAT, NTIA, and Marine-Air Systems are currently evaluating this plan and may initiate trials to resolve outstanding technical questions. The major technical question is the number of carriers and the capacity of such carriers that can be created.

Should these tests be successful, PEACESAT will be able to develop and implement a service improvement plan to maintain, strengthen, and extend existing services, and experiment with the delivery of new services such as compressed video conferencing. Realization of such a plan will effectuate a major transition in the regional telecommunications alliance called PEACESAT.

ENDNOTES

This paper is based in part on a report prepared for the PEACESAT Program at the University of Hawaii by Norman Okamura entitled Preliminary Assessment and Conceptual Design for the Use of GOES-3 to Provide Improved Services to the Pacific.

The assistance and support of the personnel and consultants of PEACESAT Headquarters in the preparation of this paper must be acknowledged. This includes Lori Mukaida, Director, Christina Higa, Operations Manager, Thomas Okamura, Programming Manager, and Calvin Fujioka, Fiscal Specialist. I am particularly indebted to Calvin for checking figures out and to Thomas for all of the graphics. The paper has benefited substantially from the discussion and dialogue that has been conducted with PEACESAT during the past five months.

The contributions of Mr. Ray Jennings and Mr. Bill Cooperman of the National Telecommunications and Information Administration, as well as Mr. Peter Williams and Mr. John Yaldwin of Marine-Air Systems must also be acknowledged since many of the ideas and issues discussed in this paper were developed as a direct result of issues raised and information provided by these organizations.

1. The PEACESAT program was initiated in 1971 with a single voice channel on ATS-1. Cooperman, W., Mukaida, L., Topping, D. 1991. "The Return of PEACESAT". Proceeding: Pacific Telecommunications Conference. Honolulu, Hawaii.

2. When the ATS-1 ran out of fuel in 1985, the PEACESAT program continued operations at the University of Hawaii using a high-frequency radio until Congress re-established the program.

3. The PEACESAT Program was re-established through a Congressional appropriation to the U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA) in 1989. Funds are made available to the University of Hawaii for the PEACESAT program through a PEACESAT Re-Establishment Cooperative Agreement.

   Once the Congressional budget has been approved, PEACESAT will submit a proposed contract amendment to NTIA. As part of the proposed contract amendment, PEACESAT will be proposing ideas on how services may be improved in the Pacific through the use of the GOES-3 satellite system.

4. See: Mukaida, L., Topping D. 1989. "Appropriate Technology: The PEACESAT Experiment". Proceeding: Pacific Telecommunications Conference. Honolulu, Hawaii;

   Proceeding: PEACESAT Policy Conference. 1992. Sendai, Japan. Mukaida, L. 1992.

   "PEACESAT Program Strategic Plan (Draft)", University of Hawaii, Honolulu, Hawaii.

5. The GOES series of satellites was built by Ford and Hughes and are used to transmit satellite imagery for weather data gathering. The image camera and/or transmitter of the GOES-3 satellite became dysfunctional. GOES-7 also experiences the same problem and may be possibly used by PEACESAT for other purposes some time in the future.

6. The Federal Emergency Management Agency (FEMA) plans to install 14 PEACESAT terminals in the Pacific during FY 93/94. FEMA became interested in PEACESAT as a result of its usefulness during Hurricane Iniki.

   In addition to the 14 FEMA sites, there are 6 other Pacific sites that are planning to install PEACESAT terminals.

7. Cooperman, W., & Conners, D. PEACESAT: Communications Satellite Services for the Pacific Islands: Satellite Feasibility Study, (US Department of Commerce, National Telecommunication and Information Administration, December, 1992. P. 2.

8. Ibid.

9. Cooperman, W. "Re: GOES Improvement Plan". Memo to: Dr. Donald M. Topping, Principal Investigator, PEACESAT, 16 November 1993.

   The memorandum does not provide specific guidance regarding the priorities of the program but was intended to raise issues regarding the effort required to expand services through creating a digital carrier network for PEACESAT.

10. There are several reports that describe the technical characteristics of GOES-3:

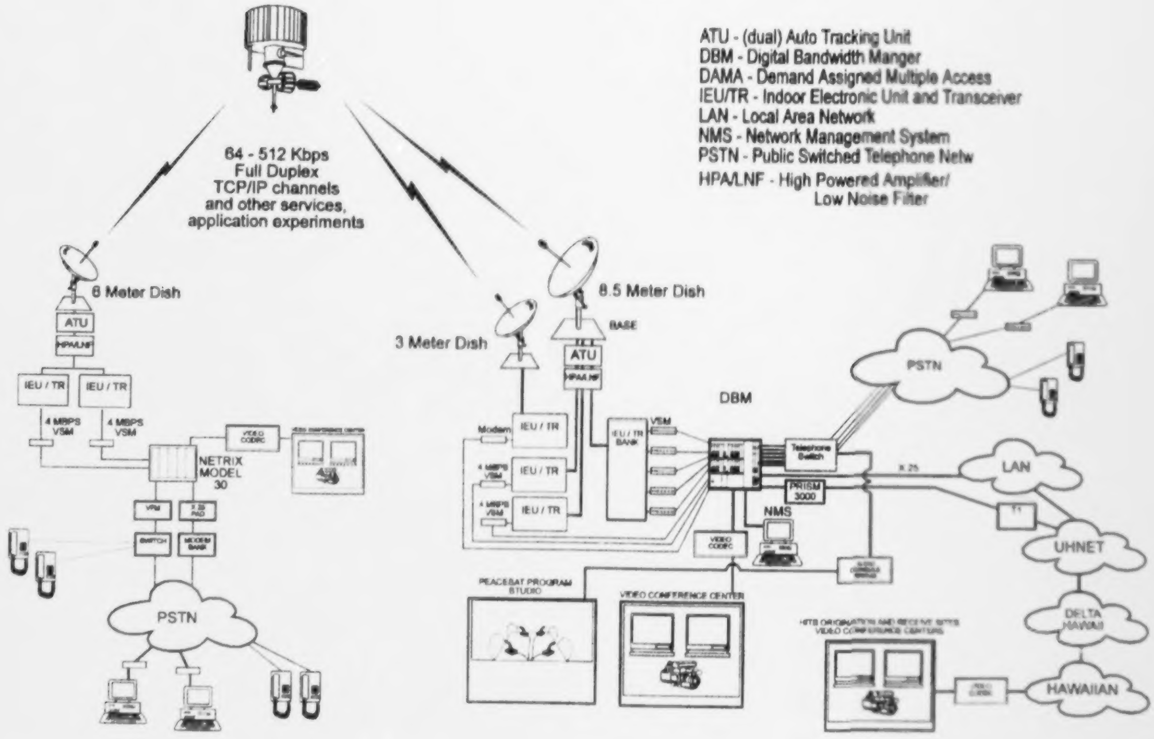
    Williams, P. & Yaldwyn, J. 1991. "Designing an Inexpensive and Innovative S-Band Earth Station Network: The Challenge". Proceeding: Pacific Telecommunications Conference. Honolulu, Hawaii.

    Leary, J. 1993. "Provision of PEACESAT Links Operating at 64 Kbps to 124 Kbps". MAS Technical Report. Wellington, New Zealand.

Leary, J. 1993. "Satellite Downlink Level Variations of GOES-3". MAS Technical Report. Wellington, New Zealand.

11. Okamura, Norman. 1993. "Preliminary Assessment and Conceptual Design for the Use of the GOES-3 to Provide Improvement Services in the Pacific". University of Hawaii, Honolulu, Hawaii.

FIGURE 1: PEACESAT GOES 3 - SERVICES IMPROVEMENT PLAN


ATU - (dual) Auto Tracking Unit
DBM - Digital Bandwidth Manger
DAMA - Demand Assigned Multiple Access
IEU/TR - Indoor Electronic Unit and Transceiver
LAN - Local Area Network
NMS - Network Management System
PSTN - Public Switched Telephone Netw
HPA/LNF - High Powered Amplifier/ Low Noise Filter
64 - 512 Kbps
Full Duplex
TCP/IP channels
and other services,
application experiments
6 Meter Dish
ATU
HPA/LNF
IEU / TR
IEU / TR
4 MBPS VSM
4 MBPS VSM
VIDEO CODEC
NETRIX MODEL 30
PSTN
3 Meter Dish
8.5 Meter Dish
BASE
ATU
HPA/LNF
DBM
Modem
IEU / TR
4 MBPS VSM
IEU / TR
4 MBPS VSM
IEU / TR
IEU / TR BANK
VSM
Telephone Switch
X.25
PRISM 3000
NMS
VIDEO CODEC
PEACESAT PROGRAM STUDIO
VIDEO CONFERENCE CENTER
PSTN
LAN
T1
UHNET
DELTA HAWAII
HAWAIIAN

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WEDNESDAY, January 19, 1994

NOTES

Are Network Management Systems Smart Enough?

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1. ABSTRACT

This article proposes a network management system architecture which takes advantage of advanced research done in expert systems and cooperation between managing agents distributed around the network. This works focuses on the management of large, public networks offering various services to a broad customer base.

2. INTRODUCTION

During the last quarter of a century worldwide telecommunications network capabilities have advanced rapidly to meet the challenge of the information age. With the emergence of intelligent networks, more obstacles are ahead for network designers and managers. Because of the increasing complexity and size of the networks, conventional network management approaches that rely heavily on human experts fail to meet the new challenges. New technologies, such as expert systems and distributed processing, have matured enough since their first appearance in the industrial world to provide robust management tools in response to these demands [3]. This article presents a network management system (NMS) architecture which takes advantage of advanced research done in expert systems and cooperation between agents (computer processes) distributed around the network. The first part of the article presents a "classic" NMS structure and the major problems associated with it. Based on the use of expert systems and advanced technologies in the network management domain [5, 7, 10], the second part describes a new architectural concept for an NMS. This work focuses on the management of large, public networks offering many and varied features to a large customer base. The conclusion restates the major points cited during the course of the article and shows the potential directions of work and research based on the proposed architecture.

3. CURRENT NETWORK MANAGEMENT SYSTEMS

3.1 FUNCTIONALITY

If there was a time when an NMS could have been given for free as part of a network, that time is now over. The cost of an NMS represents an important part of the investment in a network. To avoid having to rely on the services of a single provider, customers of telecommunications products have forced network providers to open their products to maximum connectivity. This is also true for NMSs. Today's customer wants uniform access and control of complex networks constructed of network elements supplied by more than one vendor. Tomorrow's customer will require similar management capabilities for his virtual networks. New NMSs must provide more features and must be faster to develop, easier to control, and very secure. The architecture of the NMS will have to evolve to meet these new requirements. Current NMSs offer five major functions: performance management, configuration management, fault management, accounting management, and security management.

Performance management gives an overall picture of how well the network is performing under normal or stress conditions. The performance of the network is analyzed based on expected performance thresholds which are set at network initialization. The information expected from the performance manager includes calls completed, calls lost, transmitted packets lost, and timing information. Performance management may also include routing functionality.

Configuration management controls of the configuration of each element of the network in the loading and activation of new network elements and in configuration of ports.

Fault management detects and localizes hardware and software failures in the network. Severity and fault origin lead the network manager to perform various actions in response to fault detection.

Accounting Management gives an estimate of the usage of the network component distributed per user, connection, and client.

Finally, Security Management ensures the protection of the data manipulated by the network. A number of elements, applications, and users contribute to this service. A network, by its nature as a distributed system with multiple entities, is difficult to secure while providing a useful set of applications. This article does not address the security aspects of an NMS.

This description of NMS functionality is by no means exhaustive. A number of new features and capabilities are already in place or in the laboratories (800, VPN, database access). The definitions of these features, in fact, may vary by the addition or removal of functionality from the primary network services. However, these represent the basic functions of an NMS.

Most current network management systems are very heavily focused on the management of network faults since detection and correction of network faults is generally easier than other management tasks. Although this is an important area, the real benefits of successful network management can be seen in the effective use of network resources. A change in philosophy of network management is underway in which there is a strong trend to move from reactive network problem solving to proactive problem solving and effective projection of network use and resources.

3.2 PROBLEMS

Most NMSs use a centralized architecture to perform their various tasks. One or more network elements (switches, computers, lines) are monitored by a manager agent which communicates with a central network control center (NCC). Network elements send out various state messages describing their activities (number of calls, number of switched packets, connections) and their problems (number of calls refused, number of packets lost). These messages are received by the agent which either echoes them to the NCC or preprocesses them, for example, by adding a time stamp before forwarding them to the NCC. The NCC does all analysis of the data and adjusts the network by directing actions to be performed on the network elements.

The proliferation of heterogeneous networks leads to a hierarchy of NCCs. In a sense, an NCC becomes an agent of another NCC. The management of a multiple vendor network is made possible by the development of standards in many areas of network management. Standards exist or are under development for representation of the managed information allowing communication between NCCs. Recently, much activity has been focused on the production of industrial standards. These standards address several important issues, but not all of them. There are two major problems with the NMS structure described above. Both of these problems are related to the size of the network. Large data networks are composed of thousand of network elements that are distributed across the continents. A centralized NCC is flooded with information from all over the world. This information becomes more difficult to analyze because of the complexity of the network and the variety of features provided. Also, because the analysis is centralized, the network can become swamped with useless data. For instance, when a node goes down, every network element that has a connection to that node emits messages to report the problem. The NCC receives far too many messages reporting a single problem; this contributes to the complexity of network management.

Another major problem with current implementations of network management systems is the staff required to run them. Today, an army of network management personnel is needed to monitor the network management displays to detect network fault conditions. The evolution of network management systems will bring with it a change in network management personnel. Fewer people will be needed to run the network management system. The network managers will not be forced to spend their time evaluating and fixing minor, recurrent network problems. Instead, they will have more time for traffic analysis and planning of network resources. This new generation of network management systems will promote efficient use of human resources which will translate directly into a decreased in the cost of running the NMS.

4. SYSTEM ARCHITECTURE

4.1 INTRODUCTION

The architecture of an effective network management system should address three major categories of management behavior, fault management, programmed management, and dynamic management [2].

Fault management refers to the prevention or correction of specific network element errors. When a failure occurs in the network, the NMS must be able to react quickly to provide changes to the network that maintain the best level service possible. Because it is impossible to "hard code" a solution to every fault in a large network, the network management system relies on the cooperation of the agents to define and implement a solution, on a higher level of manager agent to diagnose the problem and take action to fix it, or on trained management personnel to direct the resolution of the problem. Corrective action taken in fault management can range from making minor network configuration changes to rerouting network traffic around a problem area until field service personnel can correct the fault.

Programmed management is the application of network solutions in response to expected traffic patterns in the network. Routing strategies can be created and put into place before the expected traffic patterns occur. For example, network managers may wish to program strategies to account for the movement of network busy hours which occur at different times across the time zones of the network. Programmed management of network resources should be applied both by a centralized network manager for large scale rerouting of traffic as well as by distributed network management agents which have a knowledge of the local network traffic and can implement the solution. The strategy can be tuned by an expert system as it learns more about the traffic patterns and their impact on the network services provided.

Finally, dynamic management addresses the problem of unexpected overload of a part of the network. This is the most complex of the three behaviors to implement because it requires rapid assimilation of large quantities of data to build a useful view of the state of the network, trending and forecasting of network usage to maintain future stability of the network, and an accurate network model with which an expert system can identify actual or potential load problems. In the implementation of dynamic management, intelligent cooperation between distributed agents of an NMS can distribute the load of traffic across the network. This redistribution should be performed gradually in order to avoid overloading other parts of the network. In order to achieve this result, the various manager agents of the NMS may redirect some of the network traffic seeking an equilibrium of traffic flow. This can be done using a principle similar to the slow start algorithm. Traffic is slowly rerouted and the network is checked to see how it is responding to the new flow of traffic. This process can be escalated until the overload conditions have subsided or until new traffic flow bottlenecks begin to form. In the latter case, the process of migration of network traffic is slowed down. This method prevents the instability that can often occur with other dynamic rerouting schemes.

4.2 PROPOSED ARCHITECTURE

The proposed architecture consists of a hierarchical division of the network management tasks. Each network management agent in the hierarchy participates individually and in cooperation with other agents to control the network effectively. Figure 1 shows the distributed nature of this architecture. A Network Element Manager Agent (NEMA) controls the network management capabilities for a single network element or a small set of network elements. A Manager Agent (MA) supervises and enhances the network management functions of a set of NEMAs. Feature Agents (FA) provide network management capabilities across the network but only for monitoring and controlling specific network features. Finally, a General Manager (GM) performs the highest level of management duties, abstracting the work of its subordinate agents.

The management processes performed at the various levels of the network management hierarchy are directed by a set of expert systems using a local knowledge base at each of the agents. These expert systems are customized for the level of the NMS at which they will run; the NEMAs, for example, contain very simple expert systems while the GM contains a larger and more complex expert system for higher level analysis of network conditions. The GM is the only part of the NMS which has a complete view of the network and the management of the network. Therefore, it is used to configure and distribute the knowledge base to its subordinate components in the NMS.

The hierarchical nature of this NMS architecture provides several advantages over a centralized NMS. The first of these is modularity. Because the system is divided and distributed, changes and additions can be made to the system with only minor impact on the features and operation of the rest of the NMS. Second, each higher level of agents within the NMS further abstracts the data passed up to it. This feature frees any single element of the burden of analyzing all of the data generated by a large network. Furthermore, it allows upper level agents to focus on the efficient distribution of network resources. Third, the distribution of the network management tasks among the levels of the hierarchy, the abstraction of data passed to upper level agents, and the breakdown of problems into small manageable pieces contribute to the ease of use of this NMS. Fourth, because very little human intervention is required in solving many network problems, this architecture increases the speed of problem detection and resolution. Finally, the hierarchy promotes the scalability of the NMS to fit the network being managed.

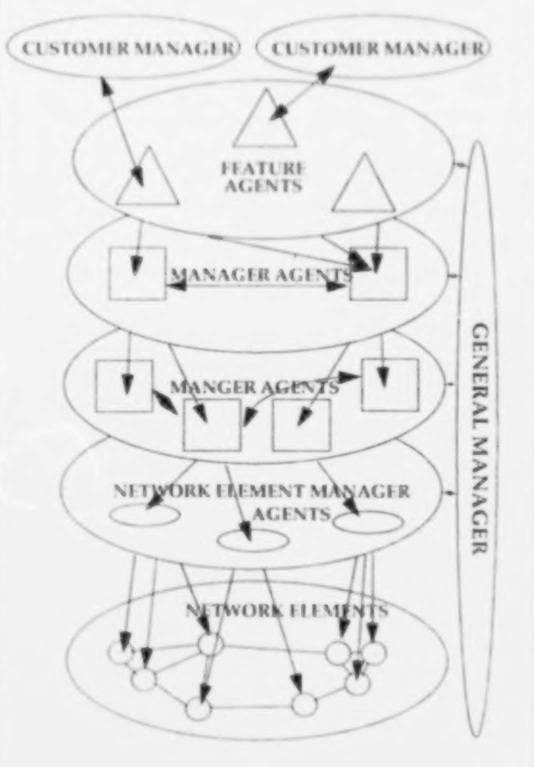

Figure 1: Distributed Intelligent NMS Architecture

The proposed architecture emphasizes the cooperation between distributed processes [6, 9] and also takes advantage of centralized management capabilities of the General Manager. The layers of this network management architecture are described in detail in the following sections.

4.3 NETWORK ELEMENT MANAGER AGENT

The Network Element Manager Agent provides network management services for one or more network elements. It receives messages from the network elements that it controls and performs the first level of analysis and filtering of those messages. The NEMA contains a very rudimentary knowledge base. This knowledge base provides only for correction of simple, very specific network element problems. Hence, the NEMA does not take an active part in the cooperation process between the agents of the NMS. Messages which cannot be acted upon directly by the NEMA as well as informational messages are forwarded to the NEMA's superior agent. The configuration of the network elements is performed by the NEMA as directed by the General Manager.

4.4 MANAGER AGENT

The Manager Agent provides network management for one or more NEMAs. When the MA manages only one NEMA, these two functions can be merged into one network management agent. The MA provides the second level of filtering of network element messages passed up from the NEMAs. It also ensures the abstraction of the physical implementation of the network and network elements to a logical representation. In general, knowledge of the physical implementation is not needed by the MA; only a knowledge of the capabilities of the network elements and the subset of the network monitored by the MA is required. This logical representation of the network and its capabilities is necessary for a higher level analysis of the conditions of the network.

The MA receives messages forwarded from the NEMAs which it controls. It uses this information, first, to augment its perception of the efficiency and health of its portion of the network, and, second, to identify specific problems. Upper level agents responding to higher level problems in the network will direct the MAs to implement solutions which they have derived. To respond to these actions, the MA may need to direct its subordinate NEMAs to perform the necessary actions. Furthermore, administrative changes from upper level agents of the network management system are sent to the MA which must update its knowledge base or network representation to reflect these changes.

Depending on the size of the network managed by the NMS, it may be useful to have a hierarchy of MAs, with upper level MAs controlling sets of lower level MAs. This scheme is particularly well suited to a network consisting of several relatively autonomous subnetworks. The upper level MA would be responsible for managing the paths between the subnetworks and coordinating the efforts of the lower level MAs which control those subnetworks.

The decision making process within the MA is also controlled by a knowledge base. The knowledge base is distributed to the MA from the General Manager so that the General Manager can ensure consistency of operation among the various MAs of the NMS.

Effective modelling of the information used by the MA is crucial to its efficient operation. This information includes not only the heuristics of the knowledge base but also a representation of the portion of the network controlled by this MA, a representation of the network management model, and the data generated by the network elements. The use of an object oriented representation of much of the MA data is recommended. The ability to encapsulate an object representation permits the disassociation of the physical from the logical, thus, abstracting the data.

The MA contains a communication module to allow the necessary discourse in exchange of information and data between this MA, its peer MAs, the NEMAs which it controls, and any upper level agents. Ideally the communication module should be able to handle at least the two major network management protocols, Simple Network Management Protocol (SNMP) and Common Management Interface Protocol (CMIP). This allows for easy communication with external network managers. The ability to communicate with external network management systems is important in the face of development of interconnected heterogeneous networks.

Processing of the messages received from the NEMAs is performed within a message analysis module of the MA. The message analysis module provides several scenarios for handling these messages. These scenarios are driven by the knowledge base of this MA and will probably include situations like the following:

> If the message is an alarm, the MA will try to solve the problem itself. The solution of the problem may involve the direction of one or more NEMAs to perform some action to rectify the problem and, perhaps, the notification to upper level agents that these changes have been performed. If the MA cannot solve the problem itself, it will have a number of options available. Again, these options are driven by the MA's knowledge base. One option available to the MA at this stage is to forward the message to an upper level agent. This is done when the MA determines that the resolution of the problem is outside the scope of this level of network management. Another option is to begin a cooperation session with its peer MAs. In this situation the MA

initiating the cooperation will direct the cooperating agents in their roles and control the completion of the solution. The MA may opt, in conjunction with other actions or in lieu of implementing a solution, to create a trouble ticket for external (likely human) evaluation and correction of the problem.

If the message is an alarm which is not directly within the scope of a given MA, the information may be logged and used in the solution of future network problems, but this MA must assume that the responsible MA has already started the process of defining a solution. This scheme ensures that no two agents are concurrently and autonomously seeking a solution to the same problem.

If the message is solely informational, the MA may consolidate it with other data retained by the MA. It can then use that data in its own future decision processes, or it can forward that data to upper level agents.

This type of decision making at the various levels of the NMS promotes a decreased flow of network management traffic around the network as well as increased usefulness of the data that is transferred between the agents of the NMS.

4.5 FEATURE AGENT

The Feature Agent provides network management services for one of the various features offered by the network or the NMS. It acts across the entire network to allow monitoring and control capabilities specific to a single network feature. Network features in this sense refer to a broad range of services ranging from customer services such as virtual private networks and video conferencing to network management specific services such as event logging. Since each distinct network feature is driven by a different FA, there is considerable flexibility in the addition or modification of network features. When a new feature is added to the network, a new FA is added to the network management infrastructure without disturbing other network features.

A Feature Agent will generally interact with several levels of the NMS. The monitoring of a feature requires the collection of information from various Manager Agents or from the General Manager. Requests can made to the FA to implement network changes with respect to the specific feature. In this case the requests must be passed along to the appropriate agent of the NMS to perform the specific task. The request may be directed to one or many MAs or to the GM. The actual network changes will be performed by the appropriate MA or, in turn, by one or more Network Element Management Agents as directed by the MA. The GM must at the same time ensure that the requested changes being made do not adversely affect the overall network performance.

If a network feature is very complex or widespread across the network, it may be useful to distribute the feature management. This would ensure timely management of that feature. In addition, depending on the complexity of the feature or the network management services provided for that feature, the FA may require a knowledge base of its own, but this will not be necessary for all FAs.

4.6 GENERAL MANAGER

The General Manager is the logical central management unit of the NMS. It has a complete view of the configuration, operation, performance, and management of the network. It is, by far, the most complex and powerful element of the distributed NMS. As the entity which oversees all agents of the NMS, the GM provides a robust user interface to monitor and control the entire network. It is the job of the GM to perform network forecasting and make recommendations for long term network reconfiguration. Furthermore, the GM must serve the role of creating and distributing the knowledge base of the entire NMS. Finally, the GM must be able to react to failures of the NMS itself. In doing so, it may choose to redistribute the management tasks to cover for agents which are having problems, or it may take over the entire responsibility of managing the network itself.

A vast array of tools are available through the user interface of the General Manager. The GM must allow the network management team to access the current data of the network state in order to provide a clear picture of the overall health of the network. The network managers should be able to use these interfaces to react to problems occurring in the network which cannot be solved directly by the distributed management system. In this case the GM should assist the network managers in the decision process by using its expertise to recommend possible solutions or analyze potential solutions recommended by the network managers themselves.

The General Manager is the only entity of the NMS which has an overall picture of the network. It must maintain the historical log of the network activity. This knowledge allows the GM to perform trend analysis for the network. In this capacity the GM is able to provide the network managers with forecasts for planning the future growth and reconfiguration of the network. The GM can also provide simulation capabilities for proposed network extensions. Network managers can suggest possible changes to the network, and the GM can assess potential risks and benefits from the implementation of these changes. This gives the GM and, in turn, the entire NMS a very real ability to direct the future of the network. The ability within the GM for network managers to focus on network analysis and forecast rather than just the normal running of the network is one of the strongest arguments for such a distributed architecture. Where it was difficult to provide these capabilities in an already overburdened central NCC, it is efficient to allow the GM to provide trending and forecasting abilities. Unlike the NCC, the GM is not overwhelmed with many of the mundane tasks of fault management. These, of course, have been distributed to the subordinate agents of the network management system.

It is the role of the General Manager create and distribute the knowledge base. Since it is the only element of the NMS which has information about the processing of all of the NMS agents, the GM must ensure that each of the agents has a knowledge base which is consistent with its peers so that it can effectively participate in cooperation processes. To ensure a consistent knowledge base and to reduce the complexity and cost of the NMS, the GM is the only element of the network management which contains an expert system with the ability to learn [4]. The learning process of an expert system is a slow and complex. It is, therefore, not appropriate for any part of the NMS except the GM to have this capability. The GM must maintain a sound representation of the network implementation and of the distributed agents of the NMS to distribute the knowledge base effectively. A distributed agent of the NMS must register with the GM when it becomes active. The agent will then receive information about its relative place in the network management hierarchy, the services that it can provide, the services that are being provided by its peers and subordinate agents, and a model of the portion of the network that it controls. As new agents become active, each of its "neighbors" must be updated to know of its existence. This strategy allows for dynamic but controlled management of the data and knowledge distributed around the network.

In the event of a failure of a portion of the network management system, the GM must react rapidly to redistribute the tasks of the failed agents. If a single agent has failed, the GM can simply assign the duties of that agent to its peer agents. If large parts of the network management hierarchy are not functioning properly, the General Manager may choose to take over some of these tasks itself. Since it maintains the knowledge base of all agents in the NMS and can perform all of the functions of those agents, the GM can act alone as a backup in the case of major failures of the distributed network management system. If the GM experiences a failure, the MAs and NEMAs can continue their basic network management tasks without the benefit of direction from the GM. However, no new network configuration or knowledge base information will be distributed to the subordinate agents until the GM is restored.

4.7 COOPERATION PROCESS

The cooperation process between agents is designed to allow network management agents to take charge of a problem, reach a suitable solution, and implement that solution without human intervention. The mechanism of cooperation proposed here makes use of a technique of expert systems known as the blackboard principle [8]. The blackboard principle was first used in speech recognition but is now being used in various applications which require cooperation between processes. The system presented here is able to use a simplified blackboard method for a number of reasons. First, the contexts for all agents that cooperate are well known and are generally common among peer agents. This avoids multiple interpretation of the same information by different agents. The GM provides the cooperating agents with all information necessary about one another to communicate the problems and their solutions effectively. Second, the solution to a problem must be found quickly, or the problem should be forwarded to an upper level agent. This is done because the problem may be too complex to be solved using the knowledge available at the level of that agent. Furthermore, the network management system cannot afford to have processes unavailable while they seek a solution. Finally, the solution found by an agent may be overruled or enhanced by an upper level agent or the GM. This allows for partial solutions to be implemented by some agents with the final solution to be directed by upper level agents of the NMS. It is not realistic for such a system to ensure that the best solution is found in every situation. The goal is to find a good solution in a short period of time and then let a more knowledgeable entity handle a long term solution if necessary. Speed is an important factor in this type of dynamic management.

The blackboard model is based on a decision tree. An agent inserts a problem into its decision tree, and that agent then tries to find a solution to the problem based on the knowledge contained in that decision tree.

In the cooperation process adopted in this architecture, an agent is responsible for defining a problem, collecting related information, and planning the implementation of the solution. A "task leader" agent ensures the coordination of efforts between the cooperating agents and the cohesion of the solution. First, the task leader states the problem in a decision tree representation and, if possible, breaks it into smaller problems. If this agent is able to solve the problem by itself, it implements the solution. Otherwise, the task leader, based on the knowledge of its environment and the capability of its peer agents, requests help from these agents by distributing the parts of the problem. A cooperating agent may find a solution; it can, instead, propose a completely new approach to the problem based on its own view of the problem and the network. The task leader gathers the results of the cooperating processes and sends a message to upper management. If no solution or only a partial solution has been found, upper management is requested to act on the problem. If a solution has been found the message is for information, but as mentioned earlier, the solution may be overwritten for some reason. The task leader is, furthermore, responsible for issuing orders to implement the solution.

The distributed architecture described above and the cooperation mechanism proposed allow for multi-agent cooperation which leads to the implementation of a solution to a problem identified by one of the agents. This architecture responds to the need to address a problem at the source, thereby, removing transmission delay. It also allows for a very flexible and simple network management system by the ranking of the decision center (lower agent, upper agent, and GM) and reaching conclusions via a knowledge based system at each level.

4.8 DATA MANAGEMENT

The choice of a database management system for the proposed architecture is not easy. As previously noted, an NMS is composed of a large number of applications. Some of these applications, such as fault management and security, are real time applications while others, like accounting and performance, are more straightforward data processing applications. The volume of data generated by a large network, even after it has been consolidated by the various levels of the NMS, is enormous. Today, database experts are divided between the relational model and the object oriented model of database management. Both of these models have advantages and drawbacks. Much useful literature has been published on this subject, and it is not the intent of this paper to review all of the issues. Rather, the most important features of both models which are pertinent for our application domain will be mentioned. The relational model, besides being very popular in the current marketplace, has the advantage of very effectively serving the data processing type applications which are incorporated in the network management system. On the other hand, an object oriented database will better represent the network elements, the knowledge base, and the other various data which is manipulated in real time. Research in both database modelling schemes has been very active in attempting to make up for the deficiencies of each system. Because none of the results have been completely satisfying, the best approach is to use each of the two models where it is appropriate and join them with a common interface. This interface will be written using a multiple paradigm language, such as LAURE [1], that incorporates paradigms from both object oriented and relational database models. This allows the various applications to use whichever representation fits best. The two databases will be closely coupled to give the maximum power with the minimum of data redundancy.

The internal interface to the databases of the NMS will ensure that the data can be translated easily from one model to the other. This scheme will save investments already made by a company in the relational domain without closing the door to migration to object oriented database technology, which offers promising data management capabilities as it matures. Figure 2 offers a pictorial representation of these concepts. The database representation described here does not assume that the databases are centralized. In fact, to be consistent with the NMS model presented here, information that is local to an NMS agent should be stored close to where is needed while still made available to remote agents. This implies the need for management of distributed data.

5. CONCLUSION

This paper has shown that the capability of building a better NMS is now available. Based on analysis of the problems specific to the approach of current NMSs, a new system architecture based on the hierarchical distribution of the network management duties, the use of expert systems, and cooperation between NMS agents is proposed. The architecture proposed is in concordance with the standards that have been developed over the last ten years in the field of network management but also allows for better performance in problem solving and a more simple decision process in network resource management. Several additional benefits to this new NMS architecture have been cited. These include increased speed of problem detection and resolution, ease of use over the centralized NMS model, and modularity and scalability of the system. This NMS, furthermore, addresses the current shift in philosophy of network management from mere fault management to overall effective use of network resources.

Others techniques may be applied successfully to obtain even better service within the NMS. Natural language interfaces, for example, could be used for collection of the expert system rules as well as user friendly display of network state information. In order to achieve a more complete flexibility of the system, an aspect of merging interpreted programming languages with a backbone of compiled programs should be investigated. This would allow for dynamic addition of new pieces of equipment and new control procedures for the various services and network elements without disturbing the system or the network. The structure of the information center is also a candidate for future research.

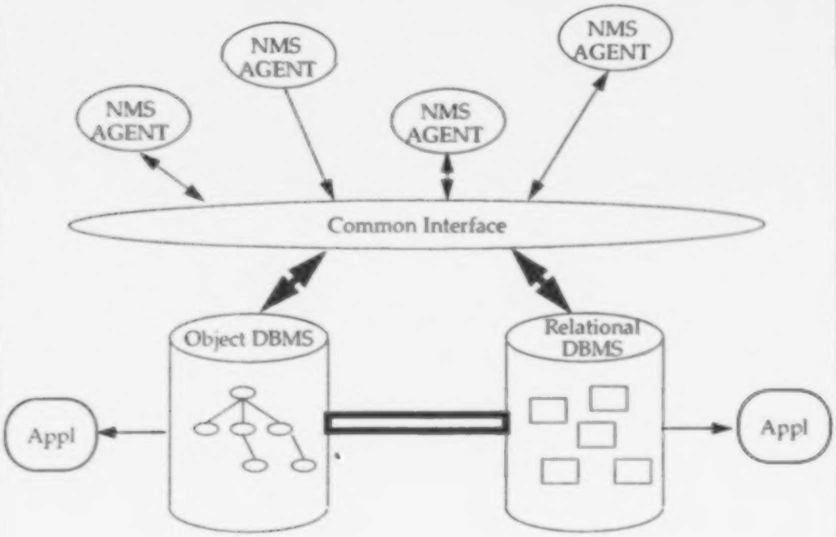

Figure 2: NMS Database Representation

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The Role of the Service Provider in Developing Telecommunications Services and Networks in a Global Marketplace

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1. ABSTRACT

Advanced telecommunications networks and services are essential to both commercial and social development. Current regulatory policy and the established monopolistic industry structure do not necessarily encourage development and innovation. The competitive service provider has an important role to play in the evolution and growth of global telecommunications.

2. Introduction

In its landmark 1984 report, "The Missing Link", the Independent Commission for World-Wide Telecommunications Development accurately highlighted the importance of telecommunications to the global economy and made a number of recommendations for stimulating the expansion of telecommunications across the world.

The Executive Summary of the report begins by identifying the importance of global telecommunications in both commercial and social terms. The following extract clearly demonstrates the Commission's desire back in 1984 to see telecommunications networks grow and develop:

> "An expanded world telecommunications network would benefit both developing and industrialised countries. The process of improving and expanding networks in developing countries will create a major market for telecommunications equipment. A more comprehensive world system will increase international traffic to the advantage of the operators. Where information flows so does commerce. More world trade and other contacts will increase understanding. An expanded telecommunications network will make the world a better and safer place."

The Commission went on to make a number of recommendations aimed at achieving the ambition of improving telecommunications on a global scale. With the benefit of some ten years hindsight since the publication of the Missing Link, this paper aims to promote the symbiotic role of the international service provider operating in a competitive and effectively regulated environment in helping to develop telecommunications networks and services.

3. The Scope of Telecommunications

Given the massive acceleration in technological development over the last decade, it is worth clarifying what we mean by the term "Telecommunications". It naturally includes the ordinary telephone, fax, telex and other everyday forms of communication. But it now encompasses a good deal more. The social and economic implications of the revolution that is occurring in the underlying technology are formidable.

Telecommunications are the nervous system of modern society today and a major source of competitive advantage to companies operating in international markets. They link not only person to person, but person to computer and computer to computer, as well as conveying broadcast and narrowcast entertainment.

As our reliance on the availability of up-to-date information grows, so the role that telecommunications has to play increases, almost exponentially. It is difficult for people in the industrialised countries to imagine life without television, financial services, credit cards, emergency calls and all the other applications which depend on modern telecommunications. Likewise, it is now impossible for companies to conduct business and compete successfully without fax, CAD/CAM, EDI, Just-In-Time Manufacturing, Electronic Mail, videoconferencing and the whole gamut of reliable modern-day corporate communications.

4. Technical Developments

When we look back at the progress that has been made over the past ten years since the publication of the Missing Link, we see that a vast amount has been achieved. Many of the previously missing links now exist both domestically, across international borders and between distant continents. The world is already a smaller place thanks to telecommunications, yet the prospects for the future are even more mind-boggling.

The process of digitalisation, the massive capacity afforded by optical fibres and the geographical coverage provided by radio technologies all work together to expand massively the scope of telecommunications. We are now seeing the introduction of thousands of miles of optical fibre cable capable of carrying millions of telephone conversations around the world. Radio and satellite technologies are now being used to provide services to previously unaccessible places. As the cost of capacity falls and geographical coverage increases, so networks may be extended to remote areas where the commercial demand is low but the social need is high.

The convergence of once separate technologies and the widespread deployment of digital switching and transmission is encouraging the development of affordable multi-media applications which can mix voice, video, data, text and image, offering flexible and intuitive access to information.

The availability of such modern services will doubtless attract investment by the world's leading companies. Such investment, not only in telecommunications, but in factories, offices, people and training, will help to finance the further development of networks and social telecommunications services. Network development and new services will encourage further investment, allowing even more network development. It is little wonder that investment by foreign multinational companies has been concentrated in those areas which offer a wide range of high quality, low-priced telecommunications services.

Unfortunately, the intrinsic network operator is not always best placed or sufficiently motivated to provide world leading telecommunications services. Many are content or otherwise limited to operating low quality networks, offering only the most basic telecommunications services, or they commonly do not have the necessary R&D resources or financial capabilities. Such situations present the ideal opportunity to stimulate development through the introduction of competition in the supply of advanced telecommunications services.

5. The Structure of the Telecommunications Industry

The vast size of the Asia Pacific market, coupled with its rich mix of cultures and languages create major obstacles to the development of modern business. While the Asia Pacific region clearly provides the world's greatest market growth potential, internationally active companies have been unable to benefit from world-class telecommunications services in many countries, due mainly to the underlying structure of the industry .

In contrast to the amazing developments in technology, the structure of the industry has remained relatively unchanged throughout the world over the last ten years. Each country normally has its national monopoly, often state-owned, whose existence is predicated on the supposition that telecommunications form a natural monopoly and that the benefits to the customer of the national operators' economies of scale outweigh the benefits which might be gained from competition.

The monopoly operator may also fulfil the role of regulator, giving it total control over market dynamics.

Such operators tended to have a cosy and tied relationship with national suppliers of equipment, the insularity of that arrangement being further compounded by a system of national standards which restricts the application of equipment largely to the country for which it was developed. Thankfully the equipment market has become more competitive, mainly due to standardisation and liberalisation by national governments and the introduction of compulsory competitive procurement regimes.

Conversely, both network infrastructure and telecommunications services have tended to remain within the national operators monopoly, especially within the Asia Pacific region. As a result, international services are generally provided on a half-circuit correspondence basis, with no accountability for service quality and performance.

Because of the fragmented nature of international services, successful companies have had to develop the necessary skills to manage and operate telecommunications networks and applications across the world themselves. Many have now turned to global Service Providers and the new breed of "Outsourcers" to help them with this task. But existing regulations and the common dependence on a single monopoly operator often limit the availability of alternative services.

6. Liberalisation Around the World

The seeds of change have been sown by the introduction of competition, first in the USA in the late seventies, followed by the UK, Japan and Australia. Competition was introduced with some trepidation at first because governments still inclined towards the natural monopoly theory. But customers have seen such significant benefits, including price cuts, improved service quality and a wider range of services, that the overall beneficial effect of competition is no longer in question in these markets.

Those countries which continue to protect the telecommunications monopoly fear that competition will undermine the monopolist's ability to fund it's universal service obligation. It is commonly felt that while the introduction of competition may improve service levels for the largest customers in central areas, the inevitable fall in prices will reduce overall revenues for the national operator. This loss of revenue will in turn lead to a reduction in service levels and increasing costs for the majority of customers in rural areas.

This has not generally been the case in those markets which have introduced competition. In reality, the introduction of competition stimulates marketing activity and product development which causes the total market to expand. Although the dominant operator's market share will obviously decrease from the 100% monopoly position, its revenues may actually increase as the total market grows in response to the introduction of new services.

Alternative methods have also been developed to fund rural and social services, through access deficit and contribution charges. Under such regimes, competitors also help fund the development of rural networks when they interconnect with the dominant national network, even though they may not provide services directly to those markets. Such a system means that the monopoly carriers no longer have to cross subsidise between services, which inevitably leads to artificially high prices on long distance and international routes in order to subsidise loss-making local services.

Competition also allows the introduction of niche players to serve the particular needs of local and rural markets which may be ignored by national operators. Indeed, one of the great failures of the US regulatory regime is the maintenance of the local Bell monopolies which prevents competition in the local loop, while competition thrives in the long distance market. In the UK, competition in the local loop is provided by the cable television companies who are allowed and encouraged to provide telephony services. The recent developments in cellular radio and Personal Communications Networks will further stimulate local competition in the future.

7. The European Market

In Europe, many countries have introduced competition in telecommunications services, while maintaining the underlying network infrastructure monopoly. This process started through the liberalisation of value-added data services, but has now progressed to include competition in basic services though the adoption of the European Commission's 1990 Directive on Competition in the Markets for Telecommunications Services.

The only remaining monopolies in Europe are the basic network infrastructure and voice telephony.

It is interesting to look at the now widely-adopted European definition of voice telephony:

> "The commercial provision for the public of the direct transport and switching of speech in real-time between public switched network termination points, enabling any user to use equipment connected to such a network termination point in order to communicate with another termination point."

It is axiomatic that all services which fall outside this definition, like basic data services, videoconferencing, private voice and closed user group voice services are now open to competition throughout Europe. As a result, Service Providers and Outsourcers are now setting up in business in France, Germany, the Netherlands and other European countries based on capacity leased from the established network operators.

While the established operators fear a loss of revenue to these new Service Providers, they are still allowed to compete on an equal footing. If they can provide equivalent services, they still have a natural advantage in the marketplace as the dominant provider of all telecommunications services with an established channel to market. Such operators will be encouraged by competition to develop new services, increase efficiency and cut costs, to the benefit of all interested parties.

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Service Providers will also become major customers of the network operators while they continue to enjoy their infrastructure monopolies. A further source of additional revenue to invest in network and service development.

8. The Asia Pacific Market

The third of the triad markets is Asia-Pacific, dominated by Japan which has introduced competition by licensing several domestic carriers, three international facilities-based carriers and a multitude of value-added service providers. To all appearances, legislation has succeeded in opening up the Japanese market, but you only have to try to do business there to realise that appearances can be deceptive. Its morass of regulations and licences is such as to frustrate the most entrepreneurial of foreign competitors. It has taken my company two whole years just to complete all the bureaucratic formalities required to launch an international telecommunications service. A simplification of the existing rules and regulations would help remove the mystery and confusion which restricts foreign investment in the Japanese IVANS market.

Australia and New Zealand have been vigorous in introducing competition and reducing protectionism. Australia went down the more established route of introducing a network infrastructure duopoly while encouraging open competition in telecommunications services under the control of a powerful independent regulator. New Zealand followed a similar course, but decided to rely totally on market forces to control the industry rather than establishing a regulatory body.

Of the two models, the Australian approach appears to have worked better in the interest of carriers, service providers and customers alike. In the absence of a regulator, constant recourse to the courts serves only to reduce the benefits of competition by slowing innovation. It is better to empower an independent regulator to control and encourage market entry, while allowing the established players to manage their own businesses and compete on a level playing field. In the long term, over regulation can be as dangerous as no regulation!

9. Is Competition Essential?

The telecommunications industry is on a relentless course of self-improvement and the barriers to competition are breaking down everywhere in the developed world and in much of the undeveloped world, too.

There are a few shining examples where first rate services are provided by monopoly suppliers, but this is normally the result of massive state funding or limited geographical size. Even in these locations it is difficult to see how competition in telecommunications services could damage the existing market, reduce overall revenues or have a negative impact on service availability.

The key measure is whether customer needs are fully met by the existing system.

10. Putting the Customer First

In any debate on the pro's and con's of competition and regulation in the telecommunications industry, it is easy to forget the central role of the customer. Although "putting the customer first" is the key principle we all follow in modern management, it is not necessarily the primary focus of politicians and policy makers.

A recent study of the top national companies across a spectrum of industry sectors in eight European countries revealed a strong desire for a liberalised telecommunications industry. Over eight out of ten senior business decision makers in the European business community actively support liberalisation of telecommunications and over half believe that telecommunications is important to the future of their business. The overwhelming majority believe that liberalisation would reduce costs of telecommunications and over 90% believe the range of telecommunications services would be extended as a result of liberalisation. Most importantly, 92% of these senior managers believe that the introduction of competition would improve the current service received from their existing telecommunications supplier!

Conversely, only 6% believe they can exert a lot of pressure on their government to accelerate the introduction and development of competition. The majority of companies believe they have little or no influence with national governments to bring about such changes and welcome the more active role of the potentially competing players to help accelerate the liberalisation process.

Although no similar survey has been carried out in the Asia Pacific region, there is no reason to believe that the outcome would be any different. Companies now expect world-class telecommunications services at an everyday price in every country across the globe. They do not care that the underlying structure of the telecommunications industry actually prohibits the seamless provision of ubiquitous services and they look to Service Providers to fill the gap.

11. The Role of the Service Provider

While network operators are busy developing domestic networks and improving basic services like voice telephony, the Service Providers have an important role to play in providing advanced seamless global services. A multinational company cannot enter into a single contract with a national operator for a global telecommunications network protected by service level guarantees, with the ease of single currency billing, single point fault reporting and multi-lingual customer service.

There are a number of Service Providers now entering the market who are capable of providing such services, but who are prevented from operating their full range of services in a number of countries across the Asia Pacific region.

If customers want seamless services that are not available from the established domestic operators and the technology exists to meet their requirements, then national regulations should allow competing suppliers to provide such alternative services.

While many countries do now allow competition in value added network services, foreign participation is often limited and the definitions of what constitutes "added value" are out of date with the needs of modern customers. Most "classic" value added features date back to the days of shared data processing and computer timesharing, when the cost of computing exceeded the cost of telecommunications. Protocol conversion, store and forward and multiple addressing technologies were essential to allow dissimilar devices to communicate and to increase operational efficiency. But the widespread availability of low priced intelligent terminal equipment and global standardisation have greatly reduced the need for such network-resident intelligence.

Telecommunications users now see "added value" as the ability of suppliers to provide a guaranteed, high quality, flexible telecommunications service and to undertake complex administrative services like single currency billing, the operation of closed user groups and the maintenance of complex global dialling plans. In effect, any service which is not provided by the national operator should now be classed as value-added or enhanced.

European regulators have avoided this problem of technological evolution by defining the basic telecommunications services which are reserved to the traditional network operators, like voice telephony. All other services are deemed to be enhanced and open to competition, albeit subject to non-market-limiting licensing regimes to ensure network integrity and the security of user information.

12. The Way Forward

A great deal of progress has already been made in building the missing links and competition is being introduced in many previously closed markets to help stimulate market growth and investment. Many bilateral and multilateral IVANS agreements have already been signed, especially between Asia Pacific countries and the US and UK. International trade barriers and limits on foreign investment in IVANS are also being removed, albeit slowly.

In addition to IVANS competition, the established national operators are also experiencing regional competition for so-called "Hubbing" business. Even governments are getting in on the act by offering attractive tax and other relocation incentives. This competition is now bringing about the development of innovative services and reduced prices for international services, which will both help stimulate market growth.

Ultimately, in order to encourage further foreign investment through the availability of advanced telecommunications services, governments and regulators across the Asia Pacific region will have to seriously consider increased competition in the provision of telecommunications services. Even if policy makers remain committed to maintaining network infrastructure monopolies, there is little or no strong argument for the current restrictions on alternative telecommunications services.

If customers want new services and the technology exists to provide such services, then regulation should not prevent their availability. While all users of telecommunications services will remain customers of the national operators for many services, they must make their requirements for choice heard.

Users have expressed their dissatisfaction with the status quo in Western markets and have brought about the introduction of competition in the US, UK, Germany and throughout Europe.

The focus is now turning to the Asia Pacific, where customers are beginning to demand supplier choice. Regulators are encouraged to consider the benefits of competition which may be introduced through the liberalisation of advanced services.

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Fundamental Technologies for Multi-media Servers

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1 Abstract

This paper discusses how the scheduling technology and the storage structure should be for multi-media servers, and suggests a way of reducing the access time. The scheduling technology, Variable Time-Slot Scheduling(VTSS), reduces the data access time for magnetic disks, and the new storage technology for Pre-Seek and Successive (PreSS) data transfer makes the VTSS scheduling more efficient. MAMI, our experimental system, has good multiple access capability using these fundamental technologies. As an example of how to use multi-media servers, this paper proposes the concept of a "Network Market Place", where multi-media information is traded like in a real market.

2 Introduction

It is becoming increasingly important to share moving picture information and to let many users access it as common property [1, 2, 3]. The usefulness of doing so was exhibited by the experimental system of the multiple access server for moving picture information (MAMI). The multiple access technology utilized in MAMI will be indispensable for future interactive TV [3]. In several interactive TV service experiments which will start this year, the multiple access technology for moving picture information and the effective structures of storage devices for this service are regarded as key technologies and intensive research will continue on the subject.

We must also pay close attention to the production of information when the distribution of information changes its form. The possibility of people being a source of information is suggested by the trend of society in the following situations: the spread of video cameras, multi-media PCs and ISDN, and children who do not feel reluctant to operate PCs. The growth in production capabilities for multi-media information is fundamentally necessary for interactive TV or other information providing industries.

This paper shows the scheduling technology for multiple access to shared moving picture information, which is essential to network storage for this purpose. A storage structure is also shown to bring out the maximum effectiveness. This technology is used in the second experimental system of MAMI, whose first system was exhibited at the last PTC, and its effectiveness is being verified.

As an example of a place where multi-media information can be traded, this paper proposes the concept of a *"Network Market Place"* where, in the near future, free and fair information can be treated and where each person can be a source of information. This concept is a first step toward increased production capability as an infrastructure; the providing of a place where demands for and supplies of multi-media information can efficiently meet in a network. Storage with high performance, especially the capacity of multiple access, is necessary to achieve a *Network Market Place* where enormous amounts of information are shared and accessed by many users.

3 Experimental system MAMI-2

An experimental system of a multiple access server for moving picture information, MAMI-1, was exhibited at PTC '93 [3]. Multiple access can be achieved in MAMI by using the transfer rate gap. A user receives a moving picture constantly and continuously at only v MB/s. The moving picture data can be dispensed from the storage subsystem at a fast transfer rate of V MB/s. As a result, V/v multiple access capability, called multiplicity, can be ideally provided in this system. Of course users can reproduce moving pictures independently from other users.

We constructed a new experimental system called MAMI-2 whose performance is improved by the scheduling and storage technologies stated in the following sections. MAMI-2's hardware consists of three parts a scheduler, client interfaces, and a disk subsystem which are connected to a VME bus. The client systems, which reproduce moving pictures, connect with client interfaces as shown in Figure 1.

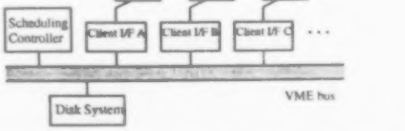

Figure 2: Hardware Configuration of MAMI-2

One important part of MAMI-2 is the scheduler which can schedule multiple video information streams. The scheduler gathers data requests from the client interfaces. It decides the order and data length of the disk access for clients and accesses the disk and transfers data to client interfaces in accordance with the order. The other is the disk control mechanism to achieve the wide transfer bandwidth provided for video streams. This paper mainly describes these two technologies, which will be indispensable for the multiple access server for moving picture information.

4 Multiple-Access Scheduling

4.1 Required Conditions for Multiple-Access Scheduling

The required conditions for multiple-access scheduling for moving picture information are high multiplicity, real time data transfer from a disk to clients, short operation response time to clients and little reproduction error.

Moving picture information is usually stored in the continuous region of a magnetic disk. Since Moving pictures are reproduced continuously during at least one scene, multiple access becomes more efficient and multiplicity increases with an increase in data which is accessed continuously by the same client. On the other hand, fair and quick operation response to all clients, such as a quick change of scenes, is necessary. The more information that is accessed by a client at one time, the longer the response time. A scheduling algorithm must provide high multiplicity and short response time simultaneously.

Some access scheduling algorithms for multimedia information have been proposed [4]. In this section, a multiplie access scheduling algorithm which provides high multiplicity and short response time to clients by changing the order of service for client requests at each access cycle is proposed.

4.2 Fixed Time-Slot Scheduling

For MAMI-1, Fixed Time-Slot Scheduling (FTSS) was used as multiple access scheduling. Clients are assigned fixed-length *time slots* by FTSS. In the time slot, each client continuously accesses moving picture information which is reproduced until new information is read in the next time slot. All Clients can access and reproduce moving pictures simultaneously if the time slots are assigned cyclically to all clients (Figure 2).

The period in which each client is assigned one time slot is called a *cycle*. Clients are assigned time slots in all cycles in a fixed order. The time from the I/O request until the end of data transfer in a time slot for a client is called the *turn-around* time.

The amount of moving picture information read in a time slot must be larger than the information to be reproduced during the cycle to prevent a break in reproduction. Since the turn-around time varies with the seek time and the latency time of the disk, the time-slot length must be longer than the maximum turn-around time to ensure the transfer of sufficient information.

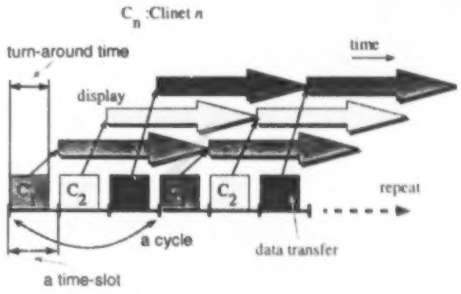

Figure 2: FTSS

4.3 Demerits of FTSS

Improvement in the transfer rate of the magnetic disk shortens the turn-around time and increases the multiplicity. A disk array is a popular technique to improve the transfer rate [6]. However, FTSS has the following demerits.

Though the time-slot length must be longer than the maximum turn-around time, the turn-around time rarely reaches maximum. As a result, there is usually vacant time during which the disk is not accessed.

A reduction in the vacant time increases multiplicity. Variable Time-Slot Scheduling (VTSS), which is used for MAMI-2, does not assign clients fixed-length time slots.

4.4 Variable Time-Slot Scheduling

VTSS does not assign fixed length time slots to clients. It allows clients to access moving picture information at an arbitrary time in an arbitrary order in an access cycle, if other clients are not accessing the disk. The same amount of moving picture information is continuously accessed in a time slot as with FTSS. VTSS keeps the response time short and provides higher multiplicity. With FTSS data access of clients is scheduled at each cycle according to the following procedures.

Procedures

1. Set the order of the clients using a disk scheduling algorithm.
2. Repeat the following procedure for each client according to the order set in 1.
    (a) The client accesses the moving picture information continuously.
    (b) Select the next client at the end of the access.
3. Clients reproduce the moving picture that is accessed in this cycle.
4. End.

VTSS is more efficient than FTSS in the following ways.

- Between two time slots in an access cycle, there is no vacant time in which moving picture information is not accessed.
- Seek time or latency time can be shortened by the disk scheduling algorithm, such as SCAN or SSTF.
- Multiplicity can be determined by the mean turn-around time.

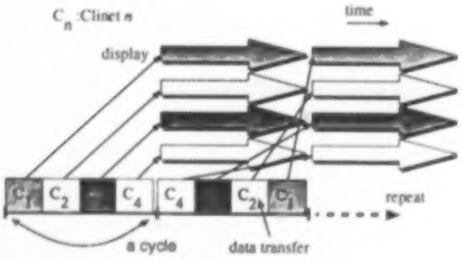

Figure 3: VTSS

5 Analysis

VTSS provides a higher multiplicity and a quick response to the client simultaneously by optimizing the order of the client's requests. When a client requests a change of scene, VTSS orders the requests of all clients to minimize the response time to the client. In a stationary state where no change of scene is requested, data requests of clients are ordered to maximize the multiplicity. The maximum multiplicity depends on the amount of moving picture information and the performance of the magnetic disk. For FTSS and VTSS, the maximum multiplicity is evaluated when the parameters of the moving picture information and the magnetic disk were given. (See Table 1) Moving picture information on a disk is assumed to be accessed in equivalent probability.

As a disk scheduling algorithm, we adopted SCAN [7] which shortens the seek time by ordering the I/O request by cylinder number.

Table 1: Parameters of the Disk and Moving Picture

Parameter		Meaning
L		Cylinder number
v	(B/s)	Transfer rate
h	(s)	Overhead for each access
$a\sqrt{l}+b$	(s)	Seek time for l track seek
c	(s)	Maximum latency time
w	(s)	Cycle length
d	(B/s)	Moving picture information

5.1 FTSS

Let t_{max} and w_s denote the maximum turn-around time and minimum time-slot length, respectively. The time-slot length must be longer than the turn-around time: then

$$w_s = t_{max} = a\sqrt{L} + b + c + h + dw/v$$

The maximum multiplicity for FTSS, denoted by M_f, becomes

$$M_f = \left\lfloor \frac{w}{w_s} \right\rfloor = \left\lfloor \frac{w}{t_{max}} \right\rfloor \quad (1)$$

5.2 VTSS

Let t_s be the sum of the turn-around time of n clients in a cycle when multiplicity is n. The distribution of t_s can be approximately expressed by normal distribution $N(\mu, \sigma^2)$ whose mean and variance are μ and σ^2, respectively. Here,[1]

$$\mu = \mu(n) = \left(\frac{c}{2} + b + h + \frac{dw}{v}\right) n + \theta a\sqrt{L(n-1)}$$
$$\sigma^2 = (\sigma(n))^2 = \left(c\sqrt{\frac{n}{12}}\right)^2$$

With VTSS, even if the sum of the turn-around time is larger than the cycle length, the delay of data transfer can be cancelled in succeeding cycles. Assuming that the delay of data transfer is not accumulated infinitely and reproduction continues without a break when the mean sum of the turn-around time is smaller than the cycle length, the next formula is

$$\mu(M_v) = \alpha M_v + \beta\sqrt{M_v - 1} \leq w. \quad (2)$$

Here, M_v denotes the maximum multiplicity with VTSS, and

$$\begin{cases} \alpha = \dfrac{c}{2} + b + h + \dfrac{dw}{v} \\ \beta = \theta a\sqrt{L}. \end{cases}$$

From Formula (2), M_v is expressed as

$$M_v = \left\lfloor \frac{w}{\alpha} - \frac{\beta}{2\alpha^2}\left(\sqrt{-4\alpha^2 + 4\alpha w + \beta^2} - \beta\right) \right\rfloor \quad (3)$$

---

[0] $\lfloor n \rfloor$ is the largest integer smaller than n.

[1] Value of θ depends on n and $\theta < 1$. When $n < 100$, $\theta \approx 1$.

5.3 Comparison

The maximum multiplicity with FTSS and VTSS is compared. Here, θ is assumed to be 1. Figure 4 graphs the maximum multiplicity for each scheduling when $d = 0.5MB/s$ and $d = 1MB/s$. The parameter values are shown in Table 2. Figure 5 graphs the ratio of M_v to M_f. Figures 4 and 5 show that VTSS has a higher multiplicity than FTSS; moreover, it becomes more efficient as the transfer ratio grows.

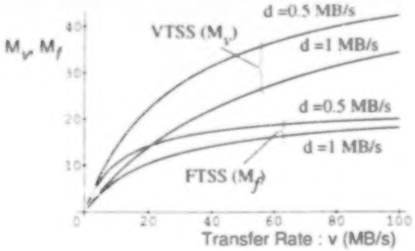

Figure 4: Multiplicity M_v and M_f

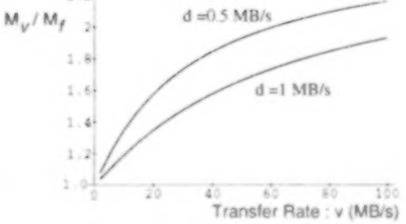

Figure 5: M_v/M_f

Now, M_v and M_f are evaluated when the other parameters of the disk are improved. Let $\alpha' = c + b + h + dw/v$. We get:

$$\lim_{\alpha' \to 0} M_v = (w/(\theta a\sqrt{L}))^2 \tag{4}$$

and

$$\lim_{\alpha' \to 0} M_f = w/(a\sqrt{L}) \tag{5}$$

So, $\lim_{\alpha' \to 0} M_v$ is larger than the square of $\lim_{\alpha' \to 0} M_f$.

Table 2: Parameter values

parameter	value		parameter	value	
$L(N)$		2235	a	0.45	$\times 10^{-3}$
$w(T_{cyc})$	1		b	1.95	$\times 10^{-3}$
h	5	$\times 2^{20}$	c	16.7	$\times 10^{-3}$

6 Storage system

6.1 Required Conditions for disk system

The effectuality of VTSS is discussed in chapter 5. Equations (4) and (5) especially show that, compared to VTSS, has a high potential for increasing multiplicity at a square order under ideal conditions where the access overhead of the storage system is nearly equal to zero and the disk transfer rate v is sufficiently high. Actually, a RAM disk can have a short enough access time and high-speed transfer rate. However, the cost is ten times that of a magnetic disk storage. Now it should be noted that the reduction of access time overhead is required from the viewpoint of occupied time of the shared bus. In our MAMI system, the scheduler knows all the addresses of the moving picture data blocks on the disk storage system at every time slot. Therefore the pre-seek or pre-fetch of the data is effective in hiding their access time overhead from the bus scheduling.

One more important requirement for the disk system is introduced by equations (4) and (5). They show that L and a are the most efficient parameters for multiplicity. These parameters are mainly defined by the disk radius. Recently, the trend in down-sizing portable work stations has accelerated the development of smaller disks; 1.8 inches or less. A disk storage system should be designed while thinking about the effectiveness of small disks. In other words, it is important to optimize the connection and control between many small disks.

6.2 Our solution: PreSS-Transfer

The storage system presented in this section makes it possible to hide the access time by using several disks instead of a single disk. During data transfer from one of the disks, the other disks seek in advance (Pre-Seek), and the disk system controller makes them ready for transfer. As soon as the first disk finishes transferring, the other disks start data transfer one after another (Successively), so called PreSS-Transfer (Pre-Seek and Successive data Transfer). However, as great as the technology advances are, the access time cannot be eliminated completely when you use a magnetic disk. So this is one advantage of MAMI's disk system.

Figure 6 shows the PreSS-Transfer concept. The dotted line means the beginning of the disk access. If PreSS-Transfer works as designed, it is possible to run the data transfer with no access time except the first one. While starting access at the same time, the disk which is ready first starts its transfer first. Each disk has done its preparation during waiting data transfer for other disks. So they fill up their vacant time on the bus with each other.

However, PreSS-Transfer has a problem. By using this system and hiding the access time, the effective transfer rate is increased. But it is less than the burst transfer rate of a single disk. The PreSS-Transfer disk system should be used

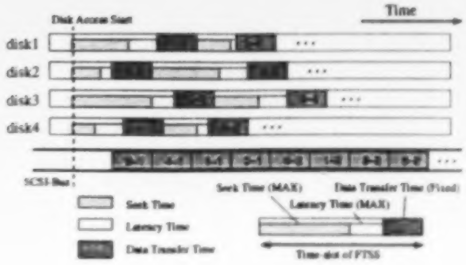

Figure 6: The Image of PreSS-Transfer

in parallel if a higher transfer rate is needed.

Our experimental system is designed as shown in Figure 7 in order to achieve a higher transfer rate. The PreSS-Transfer disk system is made of horizontal disks, shown as the dotted rectangle. The systems, which are arranged lengthways, transmit data in parallel. The bottom one is parity disks, which ensures the reliability of the total system.

The PreSS array controller integrates the whole system. It implements PreSS-Transfer by using the SCSI-command 'pre-fetch'. It is convenient to have some buffer memories on each disk unit. Pre-fetched data is stored there and transmitted successively. On each SCSI-bus, the effective transfer rate is almost equal to the burst transfer rate of a single disk, and multiplying it and the number of PreSS systems together is the total transfer rate of the system.

PreSS-Transfer makes VTSS more efficient due to hiding access time overhead from the bus scheduling and achieving a higher effective transfer rate. The PreSS array controller integrates the PreSS systems used in parallel. This achieves our desire of the maximum multiplicity limited by the bus transfer ability.

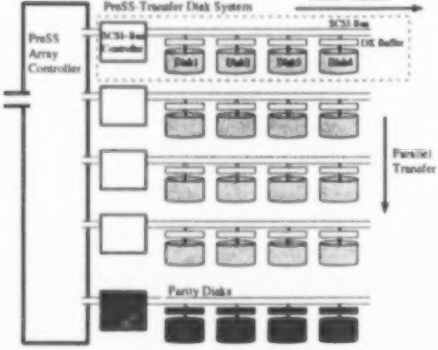

Figure 7: The Architecture of MAMI-2 Disk System

7 Applications

7.1 The Network Market Place Concept

Recently, the development of distributive machinery through networks, such as electronic mail order sales or POS systems, is revolutionizing the existing distributing system because of its speed and convenience. Such systems whose commodities themselves are supplied by a means of physical distribution, such trucks or trains , use networks as the only means of distributive management in current systems. However, the advertisement of these commodities, which is done through leaflets or television commercials, will be delivered through the network in the near future.

On the other hand, there are On-line Games or CD deliver systems, whose commodities themselves are information. These system networks are already being used as a means of distributing commodities.

It is obvious that a multi-media server is indispensable for the handling of large quantities multi-media information. In the near future, the trading of multi-media information, or the use of it as advertisements through broadband ISDN, will increase rapidly. At present we should pay close attention to two important trends. The first is that multi-media PCs will give users powerful capability of expression. This means that users will be able to send multi-media information merchandise to the network as an information provider. The second is a change from the times of mass-production to the times of mass-customization [5]. People will require information to be integrated in just the way they want it to.

These trends show the increase in difficulty in meeting user demands and providing supplies in the near future to the multi-media information market.

7.2 A primitive model for Network Market Place

Under such situations, it is important to consider that the network users want to get a place where supply and demands meet, and which works as a *"Network Market Place"*. Of course, it doesn't have to be a real market such as Ala Moana Shopping Center; it can be an imaginary market place built into a network.

Figure 8 shows a primitive connection model and the three elements that make up the *Network Market Place*; the Information Provider, Users, and Information Integrator. The figure also shows an example of what the *Network Market Place* may be required to provide. The Information Provider uses the Market in order to make his produced information common property. The Information Integrator mediates between the Information Provider and the Users in the Market, and makes mass customization possible. New business will be produced, when the Information Integrator puts together a lot of information on who has what kind of information, how to customize the information, and so on.

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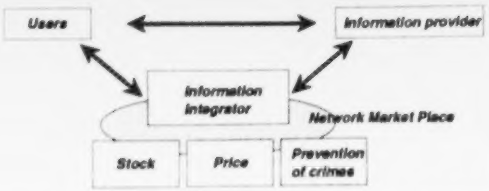

Figure 8: The Network Market Place Concept for Multi-Media Information

In a conventional *Physical Market Place*, users can meet suppliers face to face, and compare similar commodities. Users can also observe other users' actions. The *Network Market Place* should be an open place where free and fair information can be traded while proving these functions. It should be open to Anyone and at Anytime, based on Any trusted information.

7.3 Stock Management for multi-media information

The concept of stock management is also one of the important factors in the *Network Market Place*. It makes it possible for many users to simultaneously access multi-media information efficiently. Figure 9 shows an example of stock management. The process of supply and demand is worked on this Market Server. To achieve such a concept "at Anytime, to Anyone", the Market Server has to supply a demand by preparing enough stock to distribute to all users who want the information.

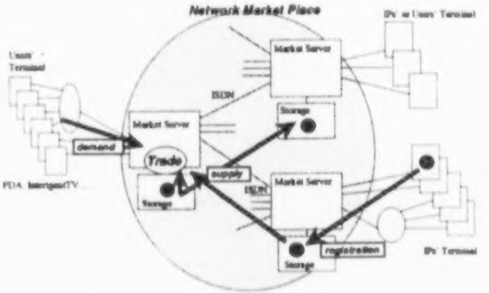

Figure 9: Network Market Place Configuration Example

It is only natural that the storehouse of the distributing information be the storage system. Each Market Server should have a storage system, which provides multiple access to the data of real time streaming, such as moving picture data or sound data.

Only after a lot of multiple access storage systems are used in the networks and the information of each is managed, will it be possible to appropriately distribute all the information to all the users. For example, big demand information or time dependent information.

It is not only the appropriate arrangement of a road and a storehouse that is important to efficiently work distributive machinery, but also the multiple access technique is also very important in distributing information corresponding to some varied load.

8 Conclusion

This paper discussed how the scheduling technology and the storage structure should be, and suggested that VTSS and PreSS-Transfer should be used as the multi-media servers. MAMI, our experimental system, has good multiple access ability with these fundamental technologies.

As an application of MAMI, this paper introduced the *Network Market Place*, where multi-media information is traded in the same way that things are sold in a market. Its infrastructure, which is made up of the network systems and controllers for distributing and storing the information, will be an important step in the development of an electrical marketing system.

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Design and Implementation of the Intelligent Peripheral Prototype System

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1. ABSTRACT

Intelligent Peripheral (IP) provides flexible, generic interfaces for end-user interactions in the intelligent network. It can adopt new technologies on a single system rather than having many separate systems at the central office. In this paper, we will examine the design and implementation of the IP prototype system. For this prototype system, we will suggest a conceptual model of IP, a modular architecture that allows new emerging technologies such as multimedia, ISDN, and B-ISDN to be easily added. With this conceptual model, the IP prototype system will be implemented on the workstations and PC's.

2 INTRODUCTION

Intelligent Network (IN) has an evolving and service independent architecture [1, 2]. It has been developed to provide new capabilities easily and rapidly to the telecommunications network. Moreover, it can offer various new services to the telecommunications service providers with their corresponding requirements. With these objectives, many international standardizations are in progress.

Intelligent Peripheral (IP), providing various subscriber interfaces, is a physical element of IN that links end-users with resources such as Dual Tone Multi-Frequency (DTMF) digit collection, DTMF digit detection, record, playback, announcement, voice recognition, and text-to-speech translation. The structure of this paper is as follows. In section 2, we will present an overview of IN relating to our prototype system. In section 3, we will propose a conceptual model of IP, where IP is divided into four parts by their functionalities. With this conceptual model, we will show a physical architecture of the IP prototype system in section 4. Concluding remarks are given in section 5.

3 INTELLIGENT NETWORK OVERVIEW

The main goal of IN is to provide new telecommunications services to subscribers in an easy and fast way. Also it improves the quality of services and reduces the cost of network service operations and managements. After introduction of common channel signaling and the digital switching system, IN has made remarkable progress.

Given the progress of IN, the International Consultative Committee for Telephone and Telegraph (CCITT) and other organizations are making bases for the international and regional standards. Our prototype system described in this paper is mostly based on CCITT's recommendations [4, 5, 6], known as IN Capability Set 1 (CS1). CCITT has developed the IN Conceptual Model (INCM) to provide a framework for the design and description of each Capability Set and for the target IN architecture. This model has a fourplane representation; service plane, global functional plane, distributed functional plane, and physical plane. These four planes represent different levels of an IN's abstraction. The service plane represents an exclusively service-oriented view of IN, which does not contain any information regarding the implementation of the services. A service is usually made up with several service features. The global functional plane provides a view of the different functionalities of an IN network. In this plane, the network is considered as a single entity. This plane contains the call processing model and service independent building blocks (SIBs). SIBs are standard reusable modules, which are used to create services. The distributed functional plane provides a view of the distributed functions of IN. This view is used to define the functional entities (FEs), their actions (FEAs), where a FE represents a grouping of related FEAs, and their relationships or information flows. The physical plane models the physical aspects of the IN structured network. It identifies the different types of physical entities (PEs) and the protocols that are used to communicate. In this conceptual model, the lower two planes are importantly considered for the implementation of IN as shown in Figure 1, where IN is composed of SCP, SSP, and IP as its physical entities. In the physical plane described in IN CS1, there are other physical entities such as service data point (SDP), network access point (NAP), adjunct (AD), and service node (SN). But we will only consider SCP, SSP, and IP relating to our IP prototype system.

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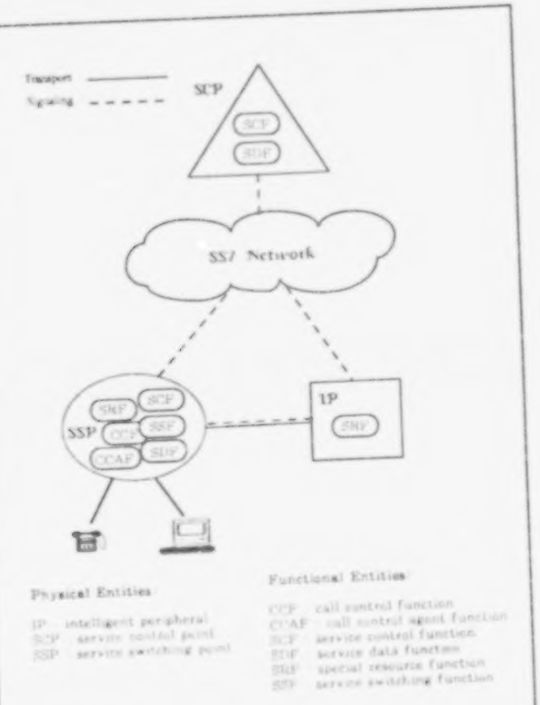
Transport
Signaling
SCP
SCF
SDF
SS7 Network
SRF
SCF
SSP
CCF
SSF
CCAF
SDF
IP
SRF
Physical Entities:
IP : intelligent peripheral
SCP : service control point
SSP : service switching point
Functional Entities:
CCF : call control function
CCAF : call control agent function
SCF : service control function
SDF : service data function
SRF : special resource function
SSF : service switching function

Figure 1. IN CS1 physical plane architecture

SCP implements a service control function (SCF) and contains an IN service logic to provide logical control to a specific service. It handles service-related processing activities such as analysis, translation, screening, and routing. It receives an IN service request from SSP and executes a service logic for the request and communicates with SSP and IP, if required. The service data function (SDF) handles the access to service-related and network-related data. It provides a logical view of the data to SCP. SSP implements a service switching function (SSF) and basically provides switching capability to a basic call. On an IN call, SSP informs SCP that an IN call is detected and waits for an instruction from SCP. SSP also connects an end user with IP to provide special resources. IP is a physical entity that implements a specialized resource function (SRF) and provides all end user interactions with IN network through control over resources. In Figure 1, each physical entity communicates through Signaling and Transport, where Signaling means control signal and Transport means user's data such as voice, sound, image, and text.

4. CONCEPTUAL MODEL OF IP

IP is a physical entity, providing resources for the requests from SCP. From now on, we will define a resource as a service unit provided by IP for a request from SCP. There may be many resources in IP such as record and playback, announcement and digit collection, and announcement and voice recognition. We divide IP into four parts as in Figure 2; resource control part (RCP), communication part (CP), resource-function part (RFP), and data part (DP).

CP is responsible for the interactions between IP and external entities such as SCP and SSP through Signaling and Transport lines. We define Control as a control signal in IP and Data as a user's data in IP, while Signaling means a control signal from external entities and Transport means a user's data from external entities. Each interface in CP receives Signaling messages from external entities and then handles the messages for sending to the protocol handling block (PHB). PHB gets messages from each interface and converts the messages into common primitives which are sent to RCP. After executing appropriate service logics for the primitives, RCP returns the results to the external entities through PHB and interfaces. The interfaces also connect Transport with Data to exchange user's data.

RFP is a collection of resource-functions, functional elements of the resources. Usually, one resource can be executed with one or more resource-functions and RFP contains these resource-functions for all resources offered in IP. DP is composed of a DB manager and data including recorded voice, sound, image, text, and others. Each data is transmitted to Transport line through Data line and also stored in DP from the external entities.

RCP is a control part of IP including a resource manager (RM), resource logic instances (RLIs), and a resource logic library (RLL). RM is a control process and makes other parts execute the requests in the primitives from PHB. When RM receives a request, it decides if the resource-functions for the resource are available. If the resource-functions are available, it creates a RLI to handle the request and waits for another request from PHB. Thus, RM has the state of resource-functions and decides whether requests are possible. RLL is a collection of execution procedures for each resource request. RLI is a temporary process, created by RM, executing codes in RLL and returns the result to PHB and then terminates. While executing the library, RLI uses RFP and DP.

5. IMPLEMENTATION OF THE IP PROTOTYPE SYSTEM

We are implementing the IP prototype system based upon the conceptual model proposed in the previous section. In order to test the IP prototype system, we also implement the SSP and SCP simulators, where the SSP simulator has switching and call decision capabilities and the SCP simulator has an IN call control capability. There are many ways to map the functional entities into the physical entities and many protocols to communicate each other [5, 6]. We chose the mapping and

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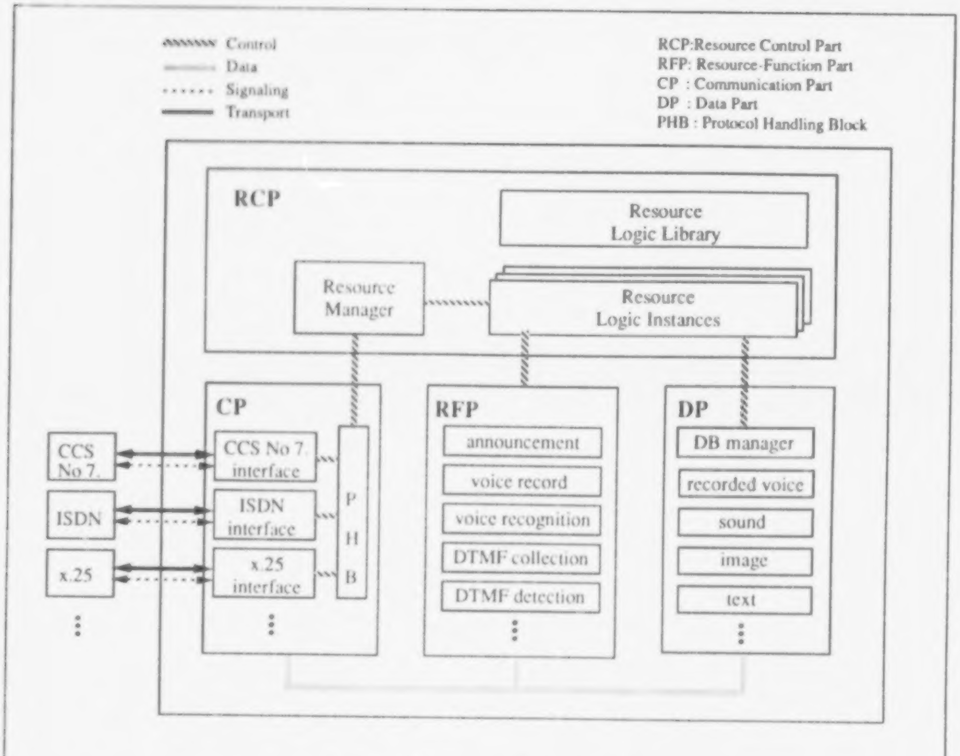
Control
Data
Signaling
Transport
RCP:Resource Control Part
RFP: Resource-Function Part
CP : Communication Part
DP : Data Part
PHB : Protocol Handling Block
RCP
Resource Logic Library
Resource Manager
Resource Logic Instances
CP
CCS No 7.
CCS No 7 interface
ISDN
ISDN interface
x.25
x.25 interface
P H B
RFP
announcement
voice record
voice recognition
DTMF collection
DTMF detection
DP
DB manager
recorded voice
sound
image
text

Figure 2. Conceptual model of IP

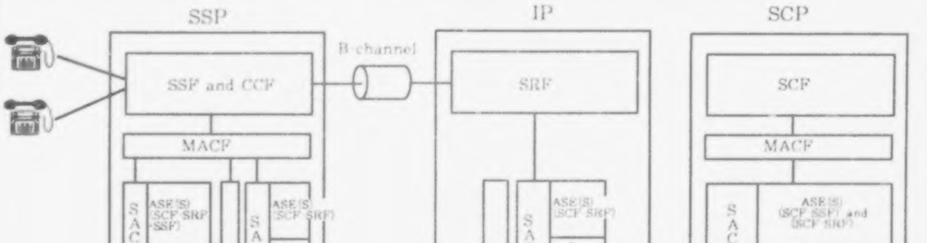
SSP
IP
SCP
B-channel
SSF and CCF
SRF
SCF
MACF
SACF
ASE(S) (SCF-SRF -SSF)
TCAP
ASE(S) (SCF-SRF)
ROSE
ASE(S) (SCF-SSF) and (SCF-SRF)
SCCP
MTP
Q.931/2
LAP-D
SS No. 7 Link
D-channel
SS No. 7 Network

Figure 3. Sample Interface for the Intelligent Network

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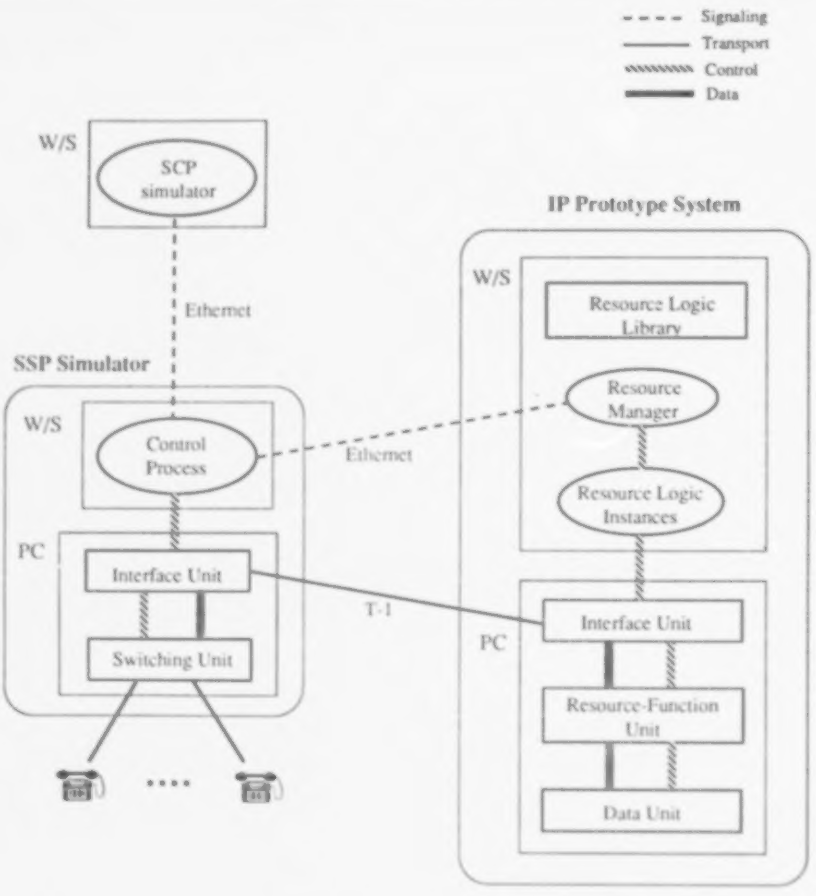

Signaling
Transport
Control
Data
W/S
SCP simulator
Ethernet
IP Prototype System
W/S
Resource Logic Library
SSP Simulator
Resource Manager
W/S
Control Process
Ethernet
Resource Logic Instances
PC
Interface Unit
T-1
Interface Unit
Switching Unit
PC
Resource-Function Unit
Data Unit

Figure 4. Physical Structure of the IP Prototype System

protocol as in Figure 3 [6].

In this structure, IP is directly connected to SSP and indirectly to SCP. IP is controlled by SCP via SSP. ISDN user-network interface [3] is used to connect IP to SSP, while SCP and SSP communicate through the signaling system number 7 network (SS No.7). If a caller tries an IN call, SSP recognizes that the call needs a special treatment and indicates SCP to perform a service logic for the call. During the execution of the service logic, if there is a need for an IP resource, SCP makes SSP connect the caller with the IP to provide the resource. Using the conceptual model and interface structure in Figure 3, our prototype system is being implemented as in Figure 4.

As shown in Figure 4, the physical entities are being implemented using the workstations and PCs. Each entity is connected by Ethernet and T-1 digital trunk. RM and RLIs are UNIX processes and RLL is a user defined library. The interface unit in IP prototype system exchanges Transport with SSP using T-1 digital trunk and joins the PC to the workstation. This unit is composed of a T-1 connecting board, a device driver, and an application program. Resource-Function unit (RFU) provides resource-functions and if a new resource-function is needed for a new service, it will be added in this unit. Now, RFU has record, playback, announcement, DTMF digit detection, DTMF digit collection, text-to-speech translation, and voice recognition capabilities. RFU is being implemented with hardware boards and device drivers. Each unit in the PC is connected with two internal buses, one is for Control and the other for Data. SSP is being implemented as IP, but it has a switching unit connecting originator and terminator. We implement SCP as a software simulator.

The interfaces for IN CS1 use existing lower-layer protocols (e.g. SS No.7 and ISDN BRI or PRI) to carry the application-layer protocol messages as in Figure 3. The focus of standardization for IN CS1 interfaces is on the application-layer protocol, referred as the IN Application Protocol (INAP). In our prototype, application processes generate application-layer messages basing INAP and then send them to the lower layer, where the messages are sent on Ethernet and T-1. SCP and SSP communicates through SS No.7 but in our prototype, application processes generate SS No.7 application-layer messages and real communications are performed on Ethernet. It is proposed that SSP and IP are connected with ISDN, where Signaling and Transport communicate on different lines, known as out-of-band method, but in our prototype, application processes generate ISDN application-layer messages and Signaling is transmitted on Ethernet and Transport is transmitted on T-1 digital trunk.

6. CONCLUSION

In this paper, we proposed a conceptual model of IP as a platform to develop an IP system. This conceptual model can meet with subscriber's requirements by adding new resources such as transmission of moving picture, video conference, and audio conference to the conceptual model. The IP prototype system is actually being implemented on the real machines. This prototype system will be used as a testbed of new services. It also keeps costs down for supporting service trial and delivery.

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Debugging and Simulation Environment for a Switching System

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ABSTRACT

This paper describes a debugging and simulation environment in developing large-scaled switching system. This environment offers rapid prototyping, early testing and debugging facilities in coding and testing steps. To reduce the overhead that occurs from testing on the target system, programmers work on host machines such as SUN workstation and VAX/UNIX systems with this environment. Thus, this environment enables them to find many software errors except real-time features on the host machine, and enables them to trace and monitor the status of processes and behaviors of signals among processes on the host machine.

1. INTRODUCTION

Today's switching system has distinguished characteristics that are real-time, embedded, interactive, and distributed. Inherently, these system contains some of the largest and most complicated software that has been constructed. Therefore, in the development of switching software, the debugging and testing activity is believed to be one of the most important process in producing the expensive and excellent-quality software. A current approach in developing most of embedded system, such as switching system, depends on cross development method. The cross development method is a particular way of developing applications using cross software tools and test environments. To develop such a switching system successfully, we need to provide simulation and debugging environment for the programmers

The advantages of using this environment are as follows:

- Able to detect and correct program errors in switching software in source-level on the host machines
- Able to debug switching software in source-level on the target system communicating with target debugger on the target system
- Able to trace and monitor status of processes and behaviors of signals among processes on the host and target system
- Able to monitor overloads of ipc(inter process communication) on network and to calculate some statistics of traffics of ipc messages
- Able to simulate switching software on the host computer to reduce considerable run-time errors before the system is tested on the target system

In this paper, we described debugging and simulation environment in developing large-scaled switching system. To reduce the overhead that occurs from testing on the target system, programmers work on host machines, such as SUN SPARC and VAX/UNIX systems with this environment. Thus, this environment enable them to find many software errors on the host machine except the errors of real-time features.

2. BACKGROUND OF THE ENVIRONMENT

2.1. ENVIRONMENT OVERVIEW

This environment consists of debugging tools such as CHILL[1] host debugger, CHILL cross debugger and simulation tools such as signal tracer, ipc monitor, animator. CHILL host debugger is an aid for tracing and debugging programs which are being executed on the host machines. CHILL cross debugger is a tool which runs on the host to debug programs that are being executed on the target system in source-level, communicating with a target debugger on the target system. It needs an interactive communication between CHILL host debugger and CHILL target debugger. CHILL target debugger is an assembly level debugger for MC68030 processors. Simulation tool consists of signal tracer and animator which are supported by the CHILL run-time system. Signal tracer is a tool for tracing and monitoring signals among processes. Using CHILL run-time system, that is supported by time manager, the switching software on the host can be simulated. In addition, ipc monitor can be used in monitoring overloads of ipc on a network and in calculating traffic statistics of ipc messages. The architecture of debugging and simulation environment ia shown in Figure 1

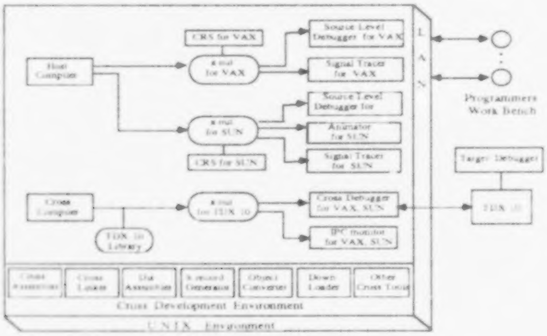

Figure 1. ARCHITECTURE OF SIMULATION AND DEBUGGING ENVIRONMENT

This environment has been developed to provide programmers who works on TDX-10(Time Division Exchange 10) switching system[8] for an effective debugging and testing facilities. However, it can be used in a wide range of embedded systems development and cross development environment as well.

2.2. HOST-TARGET CONFIGURATION

In general, The most common configuration for cross-development consists of a mid-range of host machine and single target system. In the development of TDX-10 software system, we have three super-mini VAX computers and a lot of SUN SPARC as host machines. All of host machines are connected via local area network, Ethernet. We have three model of target system in which several microprocessors such as M68030 are coupled with a ring topology. Target processors are connected to host machine via a serial lines or local area network. A lot of developers work on network terminals and access all the resources on the host machines. They can also access the target through the host/target configuration

2.3. COMPILATION AND CROSS COMPILATION

CHILL programs are compiled and linked with the CHILL run-time system[2] for processing concurrent features of CHILL on the UNIX environment. To produce debugging information, programmers should compile application programs with a debugging option. All of debugging informations are generated in a executable file, a.out. CHILL host compilers[6] support these compilation process in which they produce VAX/assembly/machine codes and SUN assembly/machine codes in the form of UNIX/BSD. Simulation environment and host debugging tool run on a host machine using this machine code.

Programs being executed on target system are compiled and linked with a CHILL run-time libraries for the target system.[6] Cross complier supports TDX-10 run-time library. For producing debugging information, programmers should compile application programs with a debugging option also. All of debugging informations are generated in the executable file in the form of UNIX system v, so called common object file format(coff). Cross compilers and ipc monitor run on a host machine using this information. Especially, cross debuggers will provide debugging facilities to debug programs being executed on target system.

2.4. CROSS-DEVELOPMENT ENVIRONMENT

Cross-development system mostly relying on the target system consists of a physical host/target environment and a tool set for developing target programs on the host machines. The host machines are development systems on which the software is developed, and the target is usually embedded systems which execute the software. All of development tools run on powerful super-mini computers and SPARC machine as the host so as to support a lot of developers. To support cross-developing CHILL programs, the tool set retains the ability to perform on-line software development by maintaining communication link between the host and target machines. We have provided a set of cross-development tools such as MC68030 cross-assembler/linker, disassembler, down-loader, object converter, object contents lister, archive/library maintainer, name lister of object files, and so on.

3. DEBUGGING ENVIRONMENT

Typically, programmers examine and debug the logic of programs by host debugger, then down-load and trace the execution status of programs on the real environment by cross debugger. Both of the above debuggers are running on the host computer and support CHILL source-level debugging features. But cross debugger runs on the host machines communicating with a target debugger which runs on the target system.

3.1. CHILL HOST DEBUGGER

CHILL host debugger[3] is a tool to assist tracing and debugging concurrent CHILL programs which are being executed on the host machines. Main function of the host debugger are to execute and trace sequential programs, execute and trace process instances, and show the current process status such as queues related to signal, region, buffer, event and ready by giving breakpoints and resuming them in terms of source lines or procedures. In order to implement CHILL host debugger easily, we modified C debugger in UNIX. But C language does not have the language concepts for various data types, the modulion (module and region) and block structures, and visibility of CHILL [1]. So we extended C debugger to make a CHILL host debugger which supporting these language concepts. Host debugger interacts with the CHILL Runtime System to get CHILL concurrent procession information.

This debugger is composed of four parts such as symbol table generator, user interface, command/language evaluator, and tracer. The first part is a symbol table generator which reads symbolic informations included in an executable program and creates internal symbol table for debugging. it maintains five auxiliary tables such as file, mode, line, function, and block tables and each table is connected by linked lists and contains several informations such as a symbol name, language types used, location or value, class, mode, a static chain for procedure arguments, dependency pertaining to a module/procedures/processes, and next link. After the construction of the symbol table, the debugger forks a UNIX process for debugging programs, and waits debugging commands. The second part is user interface which parses debugging commands by using yacc and constructs abstract syntax trees for programmers commands. This interface is similar to that of C debugger, dbx. The third part is command/language evaluator which evaluates the AST by using the symbol table and internal stack. It resolves names given as arguments, determines their physical attributes, and shows the resulting static information, in terms of CHILL by invoking the tracer optionally. This evaluator has a variable reference facility. In order to refer variable's value, it calculates the locations of the variables by using symbol table. It has also a message sending facility which can send signal messages to a certain process. The forth part is a tracer. It accesses image of processes and controls the executions. It extracts or modifies the values of the symbol table and interacts with the program being debugged by using ptrace in UNIX.

The most important purpose of CHILL host debugger is to provides a target transparent debugging methods to programmers. In other word, CHILL host debugger is responsible for equivalent results of debugging a between host debugger and a target debugger. This debugger keeps addresses of several queues related to signal, region, buffer, event, and ready by a protocol defined in the run-time system, and reads the contents of process control block of the run-time system during a debugging session. Each queue contains process definition names, instance numbers created by the run-time system, and the reasons why the processes are delayed. According to user requests, the debugger shows the status information in the form of process defination names(ID), instances, state and reasons optionally.

For user requests such as tracing a particular process/process instances or setting breakpoints at the process/process instances, the debugger stores the commands in the command table with instance numbers together, then performs the selected process only when the control reaches predefined process name(ID) or process instance number. This capability will lead users to set the conditional breakpoints on process instances.

The debugger provides another important feature: an interactive input message generation and sending. It was designed to trace the execution of process instances by stimulating data through a input messages. During a debugging session, users will key-in the values of a signal message according to the signal mode in CHILL. For this request, the debugger generates a message and send it into predefined message queue ID in UNIX kernel. Then the run-time system conveys the message to the specified process and executes the process. We resolve this message passing schemes by using msgop and msgget in UNIX. Using this feature, programmers can simulate a processing situation on the host.

3.2. CHILL CROSS DEBUGGER

CHILL cross debugger[3] which runs on the host is a tool to debug programs in source-level being executed on the target. It communicates with a primitive debugger resident on the target and maintains all the resources such as source code and symbolic information on the host, and controls debugging tasks with the assistance of the target. This is a efficient approach to satisfy the requirements such that target programs must be executed stand-alone without any constraints to be compounded by the supporting tools.

This debugger is composed of three part such as host debugger, communication link and a target debugger. The first part is a host debugger which has a similar functionality to host debugger except a tracer part; it consists of the symbol table generator, user interface, command/language evaluator, and cross tracer. Host debugger must download the executable code on the target before debugging. When invoking a debugging session, the debugger separates actual executable codes from the symbolic information, strips and transforms them into S-records, then, only downloads the actual codes on the target. Host debugger has the symbol table generator which is similar to host debugger except for re-transformation task of the symbolic information. A symbolic information is originally generated in BSD/UNIX-style and then, it is necessary to fit into target assembly language, SYSTEM V UNIX-style, for debugging a target program. On the other hand, since a symbol table generator of the cross debugger maintains the same structures and properties that of the host debugger. Thus, it reads the symbolic information from the target codes and transforms them again into cross debugger's internal symbol table. The user Interface and command/language evaluator can be achieved through the host debugger as it is. The main concept of cross debugging is implemented in cross tracer that is the entry point to the target system and can control all the cross debugging processes with a small set of the low-level operations. cross tracer was made by xptrace which is similar to ptrace in UNIX. All operations and the results to/from the target debugger[7] are handled through the cross tracer via the communication link. Host debugger receives the execution results in the form of raw data, i.e., hex-decimal values from the target. And it displays those data in the CHILL-level. The result data analysis is to identify the class of received data whether the data aims for users or for internal processing of the debugger.

The second part is a communication link which is a way between the hosts and target systems in order to download programs, to pass the low-level debugging operation to the target, or to return the results to the host. The protocol depends on host/target network configuration. It was designed to allow multiprocessor systems to be controlled from the host machines using a single interface. The protocol consists of three layers. The top layer defines a message with a set of the low-level operations. The middle layer defines packages on the data link. The lowest layer specifies the types of communication link which may be a simple serial line such as RS-232C, a local area network, or a customized ipc fabrics of the target system. The description about host/target configuration is maintained in remote facility in UNIX. Currently, RS-232C has been implemented and the combination of a remote procedure call over LAN and ipc protocol is being considered.

The third Part is a target debugger which may be thought of as the counterpart of cross debugger. It is enough to provide the primitive facilities such as reading or writing contents of memory and registers, setting breakpoints in instruction level, executing a piece of codes, extracting concurrent process information, and so on. These low-level operations can be performed either by a ROM-based debugger on the target or by means of a hardware emulator including a microprocessor development system. CHILL cross debugger transmits requests to the target debugger to perform the low-level operations and then, control will be passed to the target debugger when breakpoints are encountered or some sorts of trap. Otherwise, the target debugger is quiescent not to alter the behavior of the running program. Much current cross developing is performed using a primitive ROM-based debugger. When debugging using a hardware emulator, the debugger can control the target indirectly through an emulator to be thought as a load-sharing processor. Major advantage using this facility is that load-sharing for cross debugging would be expected to some extent.

Since the ROM-based debugger or hardware emulator usually cannot tell about status of CHILL processes and information of synchronization primitives, we need high-level debugger that has the capabilities showing informations of concurrent processes. The target debugger is such a debugger that has the low-level operation as well as provides concurrent processing information by requesting to the target operating system. Basically, it treats all running processes simultaneously.

4. SIMULATION ENVIRONMENT

The software simulation on the host computer may reduce much run-time errors before the system test on the target system or field test. For the simulation environment we have to construct the same functions on the host as on the target. The target switching system, TDX-10, has CROS(Concurrent Real-time Operating System)[9] which supports distributed, real-time and concurrent processing features. So, we made CHILL language-based run-time simulator, CRS(CHILL Run-time System), which is a kernel of simulation and contains system library primitives of CROS. Signal tracer for signal flow analysis and visualized tools for dynamic control flow and data flow are suggested with CRS for supporting visual debugging and program animation.

4.1. CHILL RUN-TIME SYSTEM

A major difference between sequential and concurrent programs exists in the definition of program state in each case. The state of a sequential program can be characterized simply by a program counter value and memory image of its data. The state of a concurrent program requires such information to be considered for each of its processes. The ability to represent program state is a fundamental capability of any debugging tool. However, if concurrent program is executed on multiple computers, making it a distributed program, communication delays make it difficult to capture its entire state at any given time. Conventional debugging tools are of little use in this situation since they are typically oriented toward monitoring the operation of what would only be a single process of a distributed program[10] &

Various concurrenting processing features in CHILL are:

- Process definition
- Process creation and kill
- Region based on monitor concept
- Event for synchronizing processes
- Message passing by using buffer
- Signal send/receive

The CHILL run-time system(CRS) includes all the above concurrent processing features defined in CHILL. It realizes the interface to programs produced by the compiler. It provides run-time environment on the host machines, which are currently VAX/UNIX and SUN SPARC, before application programs are running under target operating system. The host CHILL compiler expands each concurrent statement to one or more sequential statements in terms of CHILL syntax and semantics. The interface between application program and CRS may be written in terms of specification of procedures. CRS creates its own processes without relying on the host operating system. It allocates run-time stacks for starting processes and performs process management. It regards a process of host operating system as a virtual processor to be run CHILL processes, and accordingly it manages those processes in its context. CRS consists of kernel and CHILL primitive handlers. The kernel provides the functions such as context switching, scheduling, allocation of run-time stacks for processes, and synchronization routines invoked by the primitive handlers, which are considered to be of the most machine and operating system dependent part. The interface between application programs and CRS is accomplished via the primitive handlers. Since they are realized by procedures invoked by processes, they perform their own functions on the process contexts requesting services. However, when they call the kernel routines, they become to run on the kernel context. When the program starts, CRS kernel initiates the program status, creates outer-most process and allocates the real-time stack for processes.

4.2. SIGNAL TRACER

There are various methods for concurrent programming in CHILL. The concurrent facility supports EVENT for synchronization, BUFFER and SIGNAL for communication, and REGION for mutual exclusion among the CHILL processes. Buffers make use of common memory for the communication between processes, however, signals use ipc(inter process communication) rather than common memory. The TDX-10 software is composed of concurrent programs and these programs are executed on the multiple processors as a form of processes communicating each other by signals. So, we need to correct that a signal arrives at destination process actually via described path. The correctness of concurrent programs depends on the contents and sequence of messages transmitted between processes. For these motives, we made use of a technique that displays post-mortem views of signal transmissions after monitoring the CHILL processes in our CHILL signal tracer [5]. Some special run-time routines are used to monitor all the events and messages concerning signals and processes that occurred during the execution of the program. Because these libraries exist in CRS or CROS, programs to monitor need only be re-linked, and not re-compiled. After executing the program, CHILL signal tracer is invoked to analize and display the result of signal flow graphically.

CHILL signal monitoring library

The signal monitoring library records every event history concerning all the processes and signals occurred during the execution of the program. There are SEND and RECEIVECASE action statements concerning signal transmissions in CHILL. When these action statements are executed, the monitoring sequence is following.

1) If execution control meets SEND and RECEIVECASE statements during the execution of the program, the control is passed to _sendsig and _rcvsigcase primitives of the CRS or CROS
2) In the case of that _sendsig library is called, before calling the kernel the library records historically the status of processes sending/receiving signal and message informations. In the case of that _rcvsigcase library is called, after the execution control is passed from the kernel to the library again, the library records historically the status of processes which sent/received signal actually and received message informations.

Analysis and displaying CHILL signal event

The CHILL signal tracer is invoked to graphically display CHILL signal transmission history and process event history on SUN workstation window environments. CHILL signal tracer analizes the event history relating to processes and signals and builds internal database to use later. According to user interface, the CHILL signal tracer transforms the data to graphical data and displays them on a graphic window. Then user can trace signals and processes with mouse manipulation. The user interface is composed of two views largely. One is displaying the signal transmission situation in terms of processes. The other is displaying the signal transmission path among its processes.

4.3. ANIMATOR

Animation tools show the simulation results dynamically and graphically on the host. They are applicable for several development phases such as system design, implementation, system test and maintenance. As SDL(CCITT Specification and Description Language) is able to be transformed to the skeleton of CHILL program, which is runnable on the CRS, the processing status and the flow of signals could be represented as the SDL diagram or other graphic forms. Program structure and processing status such as control flow, data-flow, abstract data structure, module connectiveness and block/process trees could be visualized. It is also used to simulate parallel processing and performance analysis. To add or replace some functions in the maintenance phase, it is useful to test preliminarily on the host before installing them into the target operated at the field.

4.4. IPC MONITOR

Ipc monitor[4] is special purpose bus monitor for monitoring overload of ipc on the network and calculates statistics of traffic of ipc messages. This monitor makes it easy to debug hardware, supporting ipc firmware and embedded software. It is also a useful tool for measuring the traffic of ipc messages in the step of system test. ipc messages are inputed by ipc fabric and switched by D-bus. ipc monitor supports several functions extracting and verifying messages on the ipc path. This monitor was designed in order to support the following requirements.

- portable rack structure
- rapid prototyping
- easily adaptable architecture for user requirements
- support on-line debugging environments
- Board compatibility

This monitor has several functions for user. Mode conversion function switchs from on-line mode to bus monitor mode. Signal trace function extracts signal identifiers, sender of process, receiver of process and error signals from the tracing memory. Measuring function for the traffic produces the traffic measurements of ipc messages for testing in cycles. Filtering function restricts not to receive signals from some particular processes. This monitor is composed of power-pack, MPMA(Main Processing and Memory management Board Assembly), PCCA(Processor Communication Control Board Assembly), INDA(Ipc Node Assembly), MSIA(Mass Storage Interface Board Assembly), hard disk drive and cartridge tape drive.

There are several operation modes in this monitors. System Loading mode is an initial procedure for operation of the bus monitor. This procedure loads a CROS from hard disk to MPMA using MBOOT. On-line mode which is an execution environment of application programs on the CROS. In this mode, all of loading programs are serviced directly. In the bus-monitor mode. In this mode, user can execute the bus monitor processes such as signal link, measuring the amount of traffics, maintaining trace memory, recovering signals, maintaining data base and executing user functions supported by shell. User commands are transformed the ipc and transmit to bus monitor.

5. CONCLUSION

We have introduced debugging and simulation environment in the context of software development environment for large-scale switching system. This environment consist of several tools such as host debugger, cross debugger, CHILL run-time system, simulation animation tools, signal tracer and ipc monitor. Tools of the environment are composed of the well-defined interface and they are easily retargetable as well as rehostable. They run on the VAX and SUN workstations and support general MC68030 processor applications as the target system. We made this environment to develop TDX-10 switching system software. TDX-10 is a large-scale digital switching system being developed by ETRI(Electronics and Telecommunications Research Institute) since 1987 funded by KT(KOREA Telecommunication). By using this environment, programmers could reduced lots of test and trial run-time errors before the system test on the target system or filed test. To be more useful in real-time embedded systems development, it is now being extended debugging environment to the extent of fully supporting multiprograms within a single processor and a multiprocessor system. Furthermore, a window based debugging environment is being developed to provide programmers with debugging windows on workstations with powerful window system. The research of the simulation by using animation technique is on going now.

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A PRELIMINARY STUDY ON MULTIMEDIA SATELLITE COMMUNICATION SYSTEMS

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ABSTRACT

A preliminary study is conducted on multimedia satellite communication systems which realize popular OHP-like presentation with remote locations and support business process reengineering, concurrent engineering, technology transfer, training and education. The proposed CDMA (Code Division Multiple Access) or SS(Spread Spectrum) enables independent common use of the same bandwidth of a transponder and high speed burst data are sent on the same spectrum of a transponder. Thus, the proposed systems are spectrum saving and economical.

1. INTRODUCTION

Multimedia communications consist of voice, data and video improve voice only communications in accuracy and efficiency. Within a company, most works are shared by people of various departments.

Improvement of communications makes it possible to proceed works more concurrently, shortening schedule and getting better quality.

" Concurrent engineering " is demonstrating tremendous fruits in manufacturers(1).

Multimedia communications will be important infrastructure of not only concurrent engineering but also broader situations. It will support industries, trade, distribution, technology transfer, training and education.

A model of multimedia communications is OHP presentation in meetings. Combination of voice, screen and expression by face and body are effective and it is well established method. The method can be realized among remote locations using multimedia communication systems. Voice and video signals are sent continuously, and charts including text, graphs, drawings and images/pictures are sent in short period as burst data.

These systems are realized by terrestrial networks and satellite communication systems. The satellite systems are especially applicable in thin route and long distance communications.

Multimedia satellite communication systems using CDMA technology are proposed and studied here.

(1) Voice and video are usual SCPC(Single Channel Per Carrier) of QPSK(Quadruple Phase Shift Keying) modulation.

(2) High speed burst data is spread by code and sent super-imposed on voice and video using the same bandwidth of a transponder. The wide frequency spectrum required for the burst data can be saved and therefore economical.

2. TRAFFIC OF MULTIMEDIA NETWORKS

From analogy of OHP presentation, following traffic is assumed as a representative example.

(1) Voice traffic

A voice channel consists of usual ADPCM(Adaptive Differencial Pulse Code Moduration) 32 kb/s signal. As technical potential, 7 kHz broadcasting class audio will be able to be sent in the rate (recent advancement of voice compression technologies realized 3 kHz telephone class voice communication in almost 6 kb/s).

(2) Video traffic

A video channel consists of 64 kb/s compressed video of H.261 CCITT standard or slow frame rates still pictures of JPEG(Joint Pictures Experts Group) standards. About video communication, rather rough resolution(ex.100x100 dots) will be tolerated in many cases such as displayed on a small window of a personal computer screen.

(3) Burst data traffic

Burst data are sent in an average of two seconds at a rate of one page per minutes. It is assumed that a page contains 1 kbyte of characters and 25 kbyte of compressed picture consisting of 500x500 pixels, resulting in a total of 104 kb/s.

3. INVESTIGATION OF SATELLITE COMMUNICATION SYSTEMS

Simplified network configuration is shown in Fig. 1.

3.1 DOWN LINK COSIDERATIONS

Satellite transponder EIRP (Equivalent Isotropically Radiated Power) per channel Es(W) propagates distance d(m) and received by an earth station antenna of diameter D(m). The received power Pr (W) is given as

$$Pr = (Es\ \eta\ /\ Ld)(\pi D/\ \lambda_d)^2 \qquad (1)$$

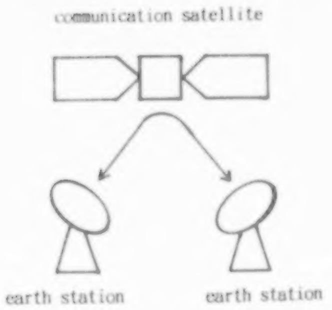

Fig. 1 SIMPLIFIED NETWORK CONFIGURATION

where η is efficiency of the antenna, λ_d (m) is wavelength of down link and Ld is down link loss which includes propagation, atmospheric absorption, rain attenuation losses and required margins. The received power has to satisfies following relationship.

$$q_{d1} = \frac{P_{r1}/R_1}{(n_3D_3P_{r3}/W + N_0)} \quad (2), \qquad q_{d2} = \frac{P_{r2}/R_2}{(n_3D_3P_{r3}/W + N_0)} \quad (3)$$

$$q_{d3} = \frac{P_{r3}/R_3}{\{n_1D_1P_{r1} + n_2D_2P_{r2} + (n_3-1)D_3P_{r3}\}/W + N_0} \quad (4)$$

where:

a) q_{d1}, q_{d2}, and q_{d3} are signal to noise ratio to achieve required BER(Bit Error Rate) and suffix 1, 2, and 3 correspond to voice, video and data, respectively.

b) P_{r1}, P_{r2} and P_{r3} are received power per channel.

c) R_1, R_2, and R_3 are bit rates including error correcting bits.

d) D_1, D_2 and D_3 are duty factors(average duration ratio).

e) N_0 is system noise power spectrum.

f) W is spread bandwidth of data which covers all voice and video spectra.

g) n_1, n_2 and n_3 are number of channels.

From Eq.(2) and (3),

$$P_{r1} = q_{d1}R_1\,(n_3D_3P_{r3}/W + N_0) \quad (5)$$

$$P_{r2} = q_{d2}R_2\,(n_3D_3P_{r3}/W + N_0) \quad (6)$$

From Eq.(4),

$$P_{r3} = q_{d3}R_3 \, x$$

$$\{\frac{(n_1D_1q_{d1}R_1 + n_2D_2q_{d2}R_2)n_3D_3P_{r3} + (n_3-1)D_3P_{r3} + (q_{d1}R_1 + q_{d2}R_2)N_0W}{W^2} + N_0\}$$

Then,

$$P_{r3} = \frac{\{1+(q_{d1}R_1+q_{d2}R_2)/W\}q_{d3}R_3N_0}{1-\{(n_1D_1q_{d1}R_1 + n_2D_2q_{d2}R_2)n_3D_3q_{d3}R_3 + (n_3-1)D_3\}/W^2} \quad (7)$$

When we assume $n_2 = k_2 n_1$, $n_3 = k_3 n_1$,

$$P_{r3} = \frac{\{1+(q_{d1}R_1+q_{d2}R_2)/W\}q_{d3}R_3N_0}{1-\{(D_1q_{d1}R_1 + k_2D_2q_{d2}R_2)k_3D_3q_{d3}R_3n_1^2 + (k_3n_1-1)D_3\}/W^2} \quad (8)$$

To indicate technical feasibility of the proposed system, a Japanese commercial communication satellite, " Super Bird " is assumed. Then, Es = 52 (dBW), G/T = 8 (dB/K) and Bt = 36(MHz) where G/T is satellite receiving antenna gain over the system noise temperature and Bt is transponder bandwidth. Compact earth stations with antenna of 1.2m diameter cross section are assumed here.
The system noise temperature Ts is 230 K. Then $N_0 = k_0T_s = 3.17\times10^{-21}$(W/Hz), where $k_0 = 1.38\times10^{-23}$ Joul/Kelvin (Boltzmann' constant).
Table 1 shows information rates, FEC(Forward Error Correction) rates, bit rate with FEC, required BER and signal to noise ratio of voice, video and data(2).

Table 1 Bit and FEC rate, BER and signal to noise ratio

	information rate	FEC rate	rate with FEC	BER	q_d
voice	32 kb/s	3/4	42.7 kb/s	10^{-4}	2.95(4.7dB)
video	64 kb/s	3/4	85.3 kb/s	10^{-6}	3.98(6.0dB)
data*	104 kb/s	1/2	208 kb/s	10^{-7}	3.72(5.7dB)

* burst data (continuous data will be added to video channels)

Burst data are spread to 3.12 Mb/s by CDMA code length of 15 and cover 4.5 MHz by BPSK(Binary Phase Shift Keying) modulation. A eighth of transponder is occupied by this system. Considering frequency of usage, $k_2 = 0.2$ and $k_3 = 0.5$ are assumed. Voice duty factor $D_1 = 0.4$, video, $D_2 = 1.0$ and data, $D_3 = 2s/1min. = 0.0333$.
Using these values, Eq.(8) gives

$$P_{r3} = \frac{2.70\times10^{-15}}{1 - 7.51\times10^{-5}\,n_1^2 - 8.23\times10^{-16}\,n_1 + 1.65\times10^{-15}} \quad (9)$$

P_{r1} and P_{r2} are calculated from Eq. (5) and (6).
Transponder EIRP per channel E_{s1}, E_{s2} and E_{s3} are derived from Eq.(1) and the total EIRP E_{st} is given as

$$E_{st} = n_1\,(D_1E_{s1} + k_2D_2E_{s2} + k_3D_3E_{s3}) \quad (10)$$

E_{st} is shown in Fig.2 as function of n_1.

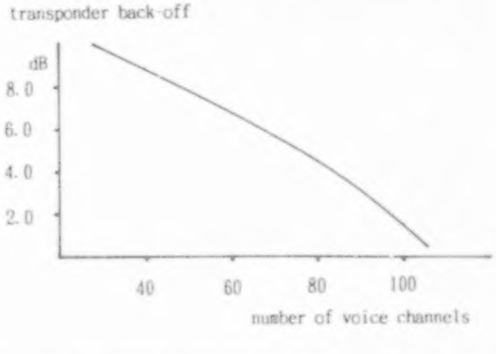

Fig. 2 TRANSPONDER BACK-OFF AS FUNCTION OF CAPACITY

From the figure, $n_1 = 80$ is selected and the total EIRP is 38.4 dBW which gives 4.6 dB back off from the eighth of the full transponder EIRP and assure operation in linear zone of the transponder. Only average power is taken into account here, and statistically, the power may be exceeded. The probability of exceeding 60 % of saturation level of the transponder is 10^{-5} from the following equations.

$$W(0) = \frac{s\ Es(a)}{s-a\{1-Es(a)\}} \qquad (11)$$

where $W(0)$ is probability of occurence of queuing of the traffic, s is the allocated channels(capacity), a is the average traffic(Erlang) and Es(a) is Erlang B equation which is presented by

$$Es(a) = \frac{a/s!}{\sum_{i=1}^{s} a/i!} \qquad (12)$$

When the capacity is exceeded, voice and video signals may be deteriorate a little but users will not sense them. (Further study will be necessary)
Voice, video and the total bandwidth is 2.39, 0.96 and 3.35 MHz, respectively ,which are included in 4.5 MHz bandwidth of the spread spectrum of burst data.
If burst data are sent by not CDMA but SCPC(QPSK), they occupies 5.82 MHz/s separately from voice and video where 40 data channels are required because it is irritating to wait channel assignment every time sending burst data. Then, the total bandwidth is 9.17 MHz which is double of CDMA case.

3.2 UP LINK CONSIDERATIONS

Required earth station power (Pe) is caluculated by following equation,

$$Pe = \frac{k_0\ q_u\ B\ Lu\ T}{G\ \eta\ (\pi D/\lambda_u)^2} \qquad (13)$$

where q_u is required uplink signal to noise ratio, Lu is uplink loss including similar factors with down link, G is satellite receiving antenna gain, T is satellite system noise temperature and λ_u is up link wave length. When q_u = 10 dB, Lu = 215.0dB and λ_u = 0.0214 m (14 GHz), the required earth station power is 0.12W, 0.33W, 1.08W and 1.53W with voice, video, burst data and total, respectively. A transmitter having about 5 W output is adequate for a single voice, video and data channels earth station. For a more channels station, higher power transmitter, larger antenna or combination of these should be selected.

3.3 CONSIDERATION ON ACCESS METHOD

Voice and video communication will continue from a few minutes to several hours. To avoid interruption, the circuit is allocated on demand and the connection is held by the end of the communication. Therefore, a network control equipment has to be located somewhere in the network and call demands are sent there through a common signaling channel or a specific CDMA code. In the other hand, the connection sequence is too cumbersome for burst data as mentioned above and connection-less approach is used. By CDMA code and/or header, the destination detects delivered messages.

4. FEASIBILITY OF PROPOSED SYSTEMS

4.1 TECHNICAL FEASIBILITY

Except following items, there will be no issue to be argued.

(1) CDMA

CDMA technologies have well been developed and the decoder will be realized by LSI or SAW(Surface Acoustic Wave) device. Development/design expenses will be diversed in mass production.

(2) Multimedia terminal

High performance PC is available at about 2000$ and video capture board less than 1000$. The availability and price down of multimedia terminals are going on day by day.

4.2 ECONOMICAL FEASIBILITY

The annual expense to occupy a eighth of a transponder is assumed as 800k$.
The monthly expense per multimedia duplex channel is 1.7 k$. An earth station will require about 1k$ expence per month. Roughly, the proposed system is less expensive than terrestrial systems with distance beyond 50 Km.

5. CONCLUSIONS

The proposed multimedia satellite communication systems can send voice, video and high speed burst data economically. The satellite systems is especially suitable for long distance thin route. The proposed systems will accelerate concurrent engineering, business process reengineering, technology transfer, training and education. Further studies are necessary in determining allowable degree of transponder saturation and in designing low cost CDMA decoder.

6. ACKNOWLEDGEMENTS

The authors wish to present their gratitude for Mr. Hisao TACHIKA, Mitsubishi Electric Corp. on his advices on CDMA technology.

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Fraud: A Complex Problem for Telecommunications Service Providers

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Abstract

Fraud is a complex problem for the telecommunications industry that effects carriers in developing and in developed countries. While fraud has existed in many forms for many years, it has now reached alarming proportions. Wireless, wireline, and private network operators are now taking measures to fight fraud. Their experience shows that effective management of fraud requires the use of sophisticated software. Digital has built significant expertise in telecommunications fraud management through fraud management projects in the United States, Europe, and the Pacific Rim.

Section 1.0 - The Simple Beginnings of a Complex Problem

Fraud can be defined as any unauthorized use of the telecommunications network accomplished through deception. Fraud effects wireless and wireline operators. Private network operators are also victims of fraud . Later, we will discuss how private network operators and public service providers are teaming to counteract fraud to their mutual benefit.

Most telecommunications validation systems were designed with some basic assumptions about users. Today some of those assumptions may be obsolete. It has always been acknowledged that some people will try to avoid paying for service through fraud. In the past, frauds were isolated and often committed only for its novelty. Today, fraud is more often committed as part of a big business driven by organized crime. The purpose of fraud is no longer novelty, but profit. The fraud perpetrator is no longer isolated, but is part of an multi-national crime organization whose purpose is to abuse the telecommunications network.

Section 1.2 - Fraud for the Wireless Service Provider

In some cases fraud loses experienced by wireless service providers amount to 6% of their revenues each year. Losses amounting to 4% of revenues are common. Even for small carriers, fraud losses exceed more than $1 million per year.

Wireless service providers are threatened by numerous types of fraud, but cloning and subscription fraud are currently most important. Fraud perpetrators accomplish cloning by duplicating the "validation handshake" of a legitimate subscriber's equipment. The network allows the fraud perpetrator to access the service because the fraud perpetrator appears to be a legitimate subscriber. To accomplish subscription fraud the perpetrator uses a false identity and false billing address when applying for service. Subscription fraud will provide the perpetrator access to service under the false identity for periods of up to two months. Once the service is discontinued due to lack of payment, the fraud perpetrator applies for service again using a another false identity.

Section 1.3 - Fraud for the Wireline Service Provider

Wireline service providers may suffer fraud losses equal to 2 or 3% of their revenues. This translates into millions of dollars per year even for relatively small wireline operations.

Wireline carriers suffer the greatest losses to tele-card fraud. Tele-card services that allow people to bill the charges for a phone call to their account by speaking or typing a tele-card identification number are easy targets for tele-card fraud, but even more sophisticated validations such as magnetic stripe and chip cards are not immune to fraud. Fraud perpetrators use identification numbers from cards that have been stolen or they use sophisticated spying techniques to acquire the identification number from unsuspecting callers. Once the identification numbers are obtained they may be distributed repeatedly and rapidly over a wide geography. This type of rapid distribution has caused some wireline operators to lose US$10,000 within the first hour of fraud having occurred.

The significance of subscription fraud has increased dramatically for wireline carriers over the past two years. Some wireline carriers lose millions of dollars a year to subscription fraud. This type of fraud is achieved in much the same way as for wireless subscription fraud, but in the case of wireline, the perpetrator rents a low cost apartment specifically for the purpose of committing fraud. The apartment is used as a base of fraud operations for up to two months -- the fraud perpetrator vacates the apartment before the carrier suspects subscription fraud due to non-payment of bills.

Section 1.4 - Fraud Examples for Wireless & Wireline Service Provider

The table below provides a wireless and a wireline example of the losses that can result from fraud. This example assumes a number of subscribers, an average monthly bill, and losses to fraud as a percent of revenue. These assumptions provide a typical example, but will not necessarily represent the situation for all carriers.

	Wireless	**Wireline**
Number of subscribers	100,000	10,000,000
Average monthly bill (US$)	80	50
Monthly revenue (US$)	8M	400M
% of revenue lost to fraud	5%	2%
Annual loses to fraud(US$)	4.8M	120M

Section 1.5 - Public Service Providers Provide Fraud Service

PBX owners can also experience millions of dollars of loss to fraud. Fraud perpetrators gain access to PBXs through trickery or technical sophistication. Once "inside" the PBX, the fraud perpetrators will rapidly distribute access to the PBX. At the end of the month, the PBX owner is obligated to pay for all of the fraudulent calls.

Today many large PBX operators rely upon the public service provider to notify them when unusual, fraud-like calling behavior is originating from their PBX. This type of fraud identification is a valuable service that public carriers can provide to PBX operators.

Fraud identification can be an important differentiator for public service providers when they compete in deregulated environments.

Section 2.0 - Telecommunications Service Providers are Taking Action

Telecommunications service providers are now taking action against fraud. For each of these types of fraud there is a way it can be detected and managed. Improved validation techniques is one way to reduce fraud, but there is no perfect validation technique. Increasingly, telecommunications service providers are turning to automated fraud analysis conducted by sophisticated software as one part of their approach to managing fraud. The software being employed may include technologies such as knowledge-based and artificial intelligence.

Section 2.1 - The Complexity of the Fraud Problem

To understand the complexity of the fraud management problem, first consider a trivial example. Suppose you only had 10 subscribers. Each subscriber would have specific calling behavior. Some would call long distance only on holidays to speak to relatives. Some would make frequent calls to international business centers. Some would never make international calls. If fraud occurred, you would notice immediately that one of your subscribers was making calls that departed from their normal calling behavior.

It's easy to identify fraud if you have only 10 subscribers, but how do you find fraud if you have hundreds of thousands or millions of subscribers? It just can't be done based upon a person's knowledge of normal customer behavior. This is why a computer equipped with sophisticated software is most appropriate for the job.

The following factors contribute to the complexity of the fraud problem

- *Number of subscribers* -- even moderate sized wireless carriers are approaching 100,000 subscribers, and growth is continuing. Wireline carriers usually have subscribers numbering in the millions.

- *The need for fast data collection and immediate data analysis.* Losses for a given case of fraud tend to grow exponentially. It is important to identify and stop each instance of fraud as soon as possible.

- *The complexity and dynamic nature of the data.* Effective fraud management requires interpretation of each call data record and the overall calling pattern of which it is part.

- *Shared call control and call accounting.* The collaboration of more than one telecom operator from point of call origination to call destination complicates not only fraud detection but also accountability.

Section 2.2 - The 3 Stage Evolution Toward Effective Fraud Management

To understand further why sophisticated software can be used to manage fraud let's look at how the approach to fraud has evolved over time. In the first stage of the evolution, carriers took a purely manual approach. When carriers first started to manage fraud a person called a fraud manager or fraud analyst was assigned to the task of identifying, measuring, and countering fraud. The fraud analyst tried to find fraud by reviewing reports based upon call data records, looking for unusual calling behavior. It quickly became obvious that there was too much data and too much remembering required for one person. We refer to the overwhelming nature of the problem when it is addressed in a manual fashion "cognitive overload".

In response to the extreme cognitive overload in the fraud management task, some carriers allocated more people and employed a relational data base employed to "assist" in the fraud management task. This second stage in the evolution is called the semi-automated stage. Soon it was realized that operating the data base and sharing information among numerous fraud analysts posed as many problems as trying to detect fraud single-handedly.

Finally, in the third stage of the evolution, some carriers realized that the best way to address fraud was to fully harness the ability of the computer to systematically review the information related to fraud. The system could automate the most tedious portions of the task and present to the fraud analyst only that information needed to confirm the occurrence of fraud and to take countermeasures. The third phase is called the fully automated phase, and the systems employed rely upon knowledge-based software. In this third phase carriers benefit from fast, thorough, and systematic fraud detection.

Every carrier is somewhere in this evolution. Each carrier must determine where they are in this process to determine what steps can be taken to address fraud management. Some carriers may decide to learn from the failures of others by skipping the manual or semi-automated phases. They enter directly into the fully automated phase.

Section 2.3 - Sophisticated Fraud Management Software: Addressing Challenges

Developing a system to address the task of fraud management poses many challenges. Some critical challenges are:

- *Volume of data* - Even small carriers process millions of records a day

- *Complexity and variation of calling patterns* - The patterns for plan old telephone service would be complex on their own. More advanced services such as 3 way calling and software defined network further complicate the calling patterns.

- *Number of customers* - Information about calling behavior must be maintained for each and every subscriber.

- *Timeliness requirements of the fraud application* - Since fraud losses grow exponentially over time, fraud analysis must take place quickly.

The high quality software design in conjunction with the following factors have been employed to address the challenges:

- *Knowledge-based technology* - Knowledge-based technology is a branch of artificial intelligence that is highly suited to the complex analysis and decision support requirements of the fraud management task.

- *Real time data collection* - Getting the data to the analysis engine fast is the first step in effective identification and counter action for fraud.

- *Integration with a pervasive information infrastructure* - Fraud analysis requires information such as the call data records. The more information that can be provided to the analysis in a timely fashion the better the analysis. The existence of an established information infrastructure is a pre-requisite for effective fraud management.

Section 2.4 - Fraud Software in Developing and Developed Economies

Fraud is a problem that effects carriers in developing as well as developed economies. In the developed economies more consistent and timely data may be available as the result of a more mature infrastructure. The challenge in the developed economies is not access to data; the problem is in analyzing the data in the face of an overabundance of data.

For the developing economies, fraud poses challenges equal to if not greater than those faced by developed economies. A large portion of fraudulent calls have international destinations which extract a steady stream of the developing economy's much needed foreign exchange. Developing economies, with tourism as a major industry, have a transient customer population. This makes fraud more difficult to track. Their developing information infrastructure may make it more difficult to access the data that can be used to manage fraud. Further, losses associated with fraud drain the developing economy's ability to achieve aggressive goals for advancement of the telecommunications infrastructure. Managing fraud with sophisticated software represents an efficient and focused approach to addressing these critical challenges.

In both developing and developed economies, a new facet of business must be considered as part of the business plan for a new service. Fraud must be anticipated. Carriers must either expect to sacrifice some of their profitability to fraud or invest in approaches to manage fraud.

Section 3.0 - Digital's Point of Reference

Digital has shown the use of sophisticated software techniques to be effective in managing fraud.

Digital has built up a substantial body of experience in fraud management by working not only in telecommunications, but also in financial services and insurance industries. Digital's telecommunications related fraud management experience includes both wireline and wireless fraud. Digital is continuing to build upon its experience through ongoing fraud management efforts fraud in the United States, in Europe, and in the Pacific Rim. Digital works with each of its partners to understand the nature of fraud they are experiencing and to define a fraud management approach that addresses each carrier's individual needs. In many cases Digital employs its world-leadership capability in knowledge-based systems to assist in fraud management.

Digital's work with wireless and wireline telecommunications service providers is based on a 4 phased plan for managing fraud. The 4 phases are:

Phase 1 - Awareness: Digital works with its clients to build an understanding of the fraud threat. A computer aided data analysis is employed to provide an initial indication of the current level of fraud and the effectiveness of an automated solution.

Phase 2 - Assessment: Once there is a sound understanding of the fraud liability, a plan for fraud management is delivered. Digital's assessment service delivers fraud management experience and results in the development of a fraud action plan.

Phase 3 - Pilot: During this critical phase, the system is operated in parallel with current operations to demonstrate compliance with the needs identified in the assessment phase. It is during this phase that users are trained and the fraud management system is integrated with the existing business environment.

Phase 4 - System Commissioning: Based upon the work conducted in the previous phases, the full implementation of the fraud management system is an easy transition. Digital fraud management consultants provide guidance in taking full advantage of the system by ensuring fraud management policies are correctly implemented and monitored.

Digital's goal in assisting service providers through the four phases is to minimize fraud losses through early detection and rapid response. The system that results provides the following benefits:

- Reduction in losses associated with wireless and wireline fraud.
- Better fraud detection, analysis, and control without commitment of costly additional resources.
- Faster and more consistent response to current types of fraud.
- Faster detection and control measures for new types of fraud.
- Rapid fraud reporting, enabling better communication with customers, and cooperation with law enforcement and regulatory bodies.

Section 4.0 - Conclusion

Fraud is a complex problem for the telecommunications industry that effects carriers in developing and in developed countries. While fraud has existed in many forms for many years, it has now reached alarming proportions. Wireless, wireline, and private network operators are now taking measures to fight fraud. Their experience shows that effective management of fraud requires the use of sophisticated software. Digital has built significant expertise in telecommunications fraud management through ongoing fraud management projects in the United States, Europe, and the Pacific Rim. The Digital 4 phased, knowledge based, approach is effective in minimizing fraud through early detection and validated case response in a timely and cost effective manner.

Communications Satellites for the Pacific Region:
1994 Status Report

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1. ABSTRACT

This report provides an up-to-date status report on the state of communications satellite activity in the Pacific region. The report covers low-earth orbiting (LEO) systems that may serve the Pacific basin as well as geostationary (GEO) satellites designed for Pacific service. Major satellite activities of 1993 are reviewed, upcoming events of 1994 are previewed and information on over 30 satellite systems is summarized in 5 tables.

2. INTRODUCTION

Communications satellite activity in the Pacific region is characterized by rapidly changing technologies and periodic entry of new proposed service providers. NTIA monitors satellite developments in the Pacific region as part of its support for the PEACESAT project, which provides educational, medical, environmental and emergency satellite communications to the Pacific island nations. We reported on the status of satellite developments in the Pacific region at PTC'92 and PTC'93 and are pleased to provide this report on satellite activities in the Pacific region for PTC'94. While we have tried to be as comprehensive as possible in our review, it is possible, even probable, that some systems have not come to our attention.[2]

The report is organized into three parts. Significant actions of 1993 for geostationary earth orbiting (GEO) are reviewed in Section 3. Low-earth orbiting (LEO) satellites are reviewed in Section 4 for those systems using frequencies above 1 GHz (Big LEO's) and in Section 5, for systems using frequencies below 1 GHz (Little Leo's). Information for over thirty operating and proposed satellite systems is summarized in five Tables. The final section, Section 6, previews satellite related activity anticipated in 1994.

3. 1993 IN REVIEW - GEOSTATIONARY (GEO) SATELLITES

Information on eight operating GEO systems in the Pacific region is found in Table 1. Table 2 contains information on GEO systems that are being planned to serve the Pacific. Information on GEO systems that will provide service to the Asia/Pacific region is in Table 3.

3.1 NEW SERVICE INITIATED

One new service, Rimsat, began in 1993, using a leased Russian Gorizont satellite that was already in orbit. Rimsat has an agreement with Tongasat to use a Tongasat orbital slot at 134° E. This location was also selected by Palapa Pacific, an Indonesian company, as the location for its service using the former Palapa B1 satellite. This satellite was relocated to 134° E longitude in 1992 and operates in an inclined orbit. Tonga and Palapa Pacific have agreed to share the use of the 134° E location during the life of the Palapa Pacific satellite. Each satellite will use transponders that do not interfere with transponders on the other satellite. After the Palapa Pacific 1 satellite is no longer usable, Rimsat will continue service from the 134° E location. Tonga and Indonesia have agreed to consider joint procurement of satellites and co-registration of future satellites at orbital slots now registered to Tonga, including 130° E and 138° E.[3]

3.2 NEW SATELLITES LAUNCHED

Two new satellites were launched during the fall of 1993. In November, a new Russian Gorizont satellite was placed at 130° E for use by Rimsat.

In October, Intelsat placed the first of its newest generation Intelsat VII satellites at 174° E to become the primary satellite for Pacific traffic. This satellite will have greater EIRP power than the existing Intelsat V satellites serving the Pacific from orbital slots at 174° E, 177° E, 180° E and 183° E.

A third satellite, Thaicom 1, was scheduled to be launched after the closing date for this article. This satellite is to be placed at 78.5° E for service to Thailand and South East Asia.

3.3 NEW PROPOSED SYSTEMS

Two new satellite services were proposed in 1993. The first is the APT Satellite Co., formed by organizations in China, Macau and Singapore. APT's satellite, Apstar 1, is on a fast-track, using the successful but older Hughes 376 design, and is intended to be launched in July 1994.

TABLE 1: Operating Geostationary Satellite Services in the Pacific Region

System	COLUMBIA	INMARSAT	INTELSAT	OPTUS (Aussat)	PACT (Pacific Area Cooperative Telecommunication)	PALAPA PACIFIC	PEACESAT	RIMSAT
Operator	Columbia Communications Corporation	International Maritime Satellite Corp.	INTELSAT, Inc	Optus Communications	Telstra Corp.	PT Pasifik Satelit Nusantara	PEACESAT	Rimsat Ltd.
Address	1088 Bishop St. Suite 2912 Honolulu, HI 96813-3126 USA	40 Melton St. London NW12EQ UNITED KINGDOM	3400 International Drive, NW Washington, DC 20008 USA	Optus House 54 Carrington St. Sydney NSW 20001 AUSTRALIA	GPO Box 7000 Sydney NSW 20001 AUSTRALIA	Mulia Center Lantai 9, Jl H.R. Rasuna Said Kav. X-6 No. 8 Jakarta 12940 INDONESIA	University of Hawaii at Manoa Honolulu, HI 96822 USA	6920 Pointe Inverness Way, Suite 150 Fort Wayne, IN 46804 USA
Phone:	1 (808) 523-8100	44 71 728 1000	1 (202) 944-6800	61 (2) 238-7000	61 (2) 287-5528	62 (21) 522-9292	1 (808) 956-7794	1 (219) 436-3800
Fax:	1 (808) 523-5010	44 71 387 2115	1 (202) 944-7898	61 (2) 238-7100	61 (2) 287-5507	62 (21) 522-9293	1 (808) 956-2512	1 (219) 436-9669
Satellite	TRDS-3	INMARSAT II F3 (primary); 2 spares	INTELSAT VII 701 (Primary); 3 INTELSAT V's	OPTUS-A3	INTELSAT	PALAPA PACIFIC 1 (Palapa B1)	GOES-3	GORIZONT
Location	174.3° W	F3 @ 178° E, spares @ 180° E and 183° E	701 @ 174° E V's @ 177°, 180° & 183° E	164°E	174° E	134° E, inclined orbit	175° W, inclined orbit	130° E & 134° E
Transponders	C-band: 12	C & L-band; equivalent of 250 voice circuits	INTELSAT VII- C-band: 26 Ku-band: 10	Ku-band: 15, one covers the South West Pacific	Uses a C band global Intelsat transponder	C-band: 22 usable	L-band: 1 (D) S-band: 1 (U)	C band: 6 Ku band: 1
Downlink EIRP (dBW) maximum	36.2	II F3 - 39	INTELSAT VII C-band: 33 Hemi/zone/spot, 26 global; Ku-band: 44.5/47	37	26	38	26.8 (hard limiting transponder)	C: global beam 27.5, spots to 45; Ku: 38.5 spot
Service Area	US mainland & Hawaii; Guam; Hong Kong; Japan; Korea; Mongolia; PRC; Philippines; ROC; Russia	Full-disk (global)	Full-disk (global), two hemi, zone and spot beams	South West Pacific; (beam shares use of antenna beam with service to PNG--service to either South Pacific or PNG supported)	Full-disk (global) beam; Cook Is, Fiji, Kiribati, Nauru, Niue, PNG, Solomon Is, Tuvalu, Australia and NZ participating	Hawaii, Micronesia, Japan, Hong Kong, ROC, Philippines, parts of PRC	Full-disk (global)	C-band: Full-disk (global), zone and spot beams; Ku-band: spot beam
Type of Service	Video, Voice, Data	Voice, Data, Fax	Video, Voice, Data	Video, Video, Data	Switched voice, fax, data services; new DAMA-NET digital service offers teleconferences, public and private networks	Video, Voice, Data	Voice, Data, Fax	Video, Voice, Data
Satellite Launch	1991	1992	INTELSAT VII - 1993	1987	1993	1981	1978	1993 (satellite @ 130° E)
Estimated Life	10 years	13 years	17 years	1997	15 years	Till 1994/5 (now in inclined orbit)	To be determined	@134° to 1994

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TABLE 2: Proposed Geostationary Satellites in the Pacific Region

Service	INMARSAT	INTELSAT	PACIFICOM	PACSTAR	PANAMSAT	RIMSAT	TONGASAT	UNICOM
Operator	See Table 1	See Table 1	TRW, Inc.	Pacific Satellite Inc.[4]	Pan American Satellite	See Table 1	Friendly Island Satellite Co.	Unicom Satellite Corp.
Address Phone: Fax:	See Table 1	See Table 1	Space and Technology Group One Space Park Redondo Beach, CA 90278 USA 1 (310) 812-4321 1 (310) 812-7111	c/o Judith O'Neill Steptoe & Johnson 1330 Connecticut Ave. NW, Washington, DC 20036, USA 1 (202) 429-6212 1 (202) 429-3902	One Pickwick Plaza, #270 Greenwich, CT 06830 USA 1 (203) 627-6664 1 (203) 622-9163	See Table 1	LPL Center 22nd Floor 130 Alfaro St 1200 Makati Manila PHILIPPINES 63 (2) 817-6128 63 (2) 817-6112	418 East Cooper Suite 202 Aspen, CO 81611 USA 1(303) 920-2400 1(303) 920-2426
Satellite	INMARSAT III	INTELSAT VII 703; INTELSAT VIII 801 & 802	PACIFICOM-1	PACSTAR-1	PAS-2	GORIZONT, EXPRESS	Tongasat has 7 orbital slots registered with the ITU, @ 70°E, 83.3°E, 130°E, 134°E, 138°E, 142.5°E and 170.75° E.	UNICOM I and UNICOM II
Location	See table 1	703 @ 177° E; VIII's to other Pacific slots listed in Table 1	172° E	167.45° E	169° E	GORIZONT @ 142.5° E; EXPRESS @ 134° E		I: @170.75° E II: @ 70° E
Trans-ponders	C & L-band: more than 1,000 voice circuits	See Table 1 for VII information; 801/802 C: 38 Ku: 6	C: 8 Ku:11	C: 12-24 Ku: 4	C: 16 Ku: 16	GORIZONT (See table 1) EXPRESS: C: 10, Ku: 2	Tongasat has joint venture agreements with Rimsat and Unicom that permit those companies to place satellites at the Tongasat registered orbital locations.	I: C-24, Ku-6 II: C-12, Ku-12
Downlink EIRP (dBW) maximum	48	VIII - C: 34.5 hemi/zone, 29 global; Ku: 44/47	C: 27.7 - 37.7 Ku: 37.6-56.5	C: 36-40 Ku: 48-54	C: 33-40 Ku: 44-52	EXPRESS: C: global beam 27.5, hemi beam 29.5, zones to 45; Ku: 38.5		C: 36 Ku: 50
Service Area	Global beams and reconfigurable spot beams	801/802 will have 6 global beams, 12 hemispheric beams and 20 zone spot beams	C: Asia, South Pacific, Western US, global receive only; Ku: Asia and Western US	C: Pacific islands, Hawaii, Japan, SE Asia, US West Coast	C: Pacific islands, SE Asia, China, Japan, US; Ku: China & Japan south to Aust/NZ	EXPRESS: C: global, zone and steerable spot beams; Ku: steerable spot beams		I: SE Asia, Japan, South Pacific, US West Coast and Hawaii II: SE Asia, India, Japan, Europe
Types of Service	Voice, Data, Fax: Navigation	Video, Voice, Data	Video, Voice, Data	Video, Voice, Data	Video, Voice, Data	Video, Voice, Data		Video, Voice, Data
Satellite Manufac-turer	Martin Marietta Astro Space	VII: Space Systems/Loral; VIII: Astro Space	Not announced; applicant is satellite manufacturer	Not announced	Hughes 601	Scientific Production Institute for Applied Mechanics[5]		Fairchild Ultrasat
Launch Date and Vehicle	Late 1995	703: July, 1994 VIII's: 1996	1997/98	Expects to make announcement on mid-1994 service	May 1994 Ariane	Feb. and June, 1994 on Proton		1995
Status	Satellite under construction	Satellites under construction	Received conditional license from the FCC	System is fully notified through ITU	Proposed move to 169° E to reduce conflict with Pacstar @ 167.45° E.	Satellites under construction		Using Tongasat orbital slots
NOTE	Columbia (See Table 1) has filed for a Columbiasat satellite @ 165° W but is concentrating on its TDRS activities noted in Table 1. It has deferred action on the Columbiasat project for the present.							

TABLE 3 Summary of Geostationary Satellite Proposals in the Asian Region

SATELLITE	ORBITAL SLOT	DATE	SERVICE	DESCRIPTION
APSTAR	1: 131°E 2: 134°E	1: 1994	Fixed Satellite Service	Apstar 1, a Hughes 376 satellite, will be launched in 1994 by the Long March rocket. The satellite will cover Japan, Korea, China and much of SE Asia. Apstar 2 will be a Hughes 601 satellite and will provide coverage from Japan to the Middle East.[6] Apstar 2 is proposed @ 134° E, an orbital slot currently occupied by Rimsat (Tongsat registration)
ASIASAT	100.5° E	1994	Fixed Satellite Service	Asiasat-2, built by Martin Marietta Astro Space, will be the second regional spacecraft operated by Asia Satellite Telecommunications Co. Ltd. Asiasat-2 is scheduled to be launched on the Long March rocket.
ASIASPACE	To be determined		Direct Audio Broadcast Satellite (DAB)	WorldSpace of Washington, DC is planning a DAB satellite for Africa to provide 54 channels of radio on the L-band. Special radios are being developed by Motorola. The Afrispace satellite would be followed by one for the Caribbean, one for South America and finally the Asiaspace satellite for South East Asia and the Pacific Rim.
INDOSTAR	106.1° E	1995	Direct Broadcast Satellite and Direct Audio Broadcast	Indostar will establish a DBS satellite that will provide three transponders for direct television broadcasts and two transponders for CD quality digital radio. The satellite will operate in the S and L bands. Indostar-1 is fully booked and a second satellite at 115.1° E[7]
INTELSAT	91.5° E, 85°E or 95° E	1994	Asia-Pacific landmass regional Fixed Satellite Service	Intelsat plans to place an EXPRESS satellite at 85° or 95° in June 1994 to serve the Asia-Pacific Region service area. The Intelsat 501 satellite @ 91.5° in inclined orbit now serves this area. A VIII-A satellite (805) will be launched in 1996 with steerable beams and power to better serve the Asian landmass.
KOREASAT	113° E or 116° E	1994/5	Fixed Satellite Service and Direct Broadcast Service	The Koreasat project is a two satellite Ku-band project to serve South Korea with telecommunications and direct broadcast capability. The satellites will be built by Martin Marietta, with one satellite designed to operate with horizontal polarity, the other using vertical polarity.
KUPON	55° E, 91.75° E, 86.5° E, 9° W	1994	Fixed Satellite Service	The Globostar system, based on the Kupon satellites, is being established by a Moscow company, Global Information Systems, Inc. The Globostar/Kupon satellites will have 16 Ku or 8 Ku and 8 C band transponders. The satellite will meet the data and communications needs of the Russian banking industry and is being marketed in the West by Space and Scientific, a UK based company.[8] Globostar also has agreed with a company in the Philippines to provide domestic service to that country.[9]
MEASAT	91.5° E, 95° E, or 148° E	1994/5	Fixed Satellite Service	The Measat project will be based on a Hughes 376 satellite with 12 C bands and up one or two Ku bands.[10] Measat will provide coverage to Malaysia, the Philippines and parts of Indonesia.
SAT/TRACS	To be determined		GPS location data and messaging from remote sensors	Energetics Satellite plans a worldwide network of 3 GEO satellites (with 3 back-ups) to receive and relay location and data information using the Ka-band (20-25 GHz). System will replace the LEO system noted in Table 4. FCC applications will be filed after fund raising is completed. Inexpensive transceivers will be 2.5" by 5" by 1".
THAICOM	78.5° E	1993	Fixed Satellite Service	Thaicom-1 was to be launched in December 1993 by the Ariane launcher. Thaicom-1 has 10 Ku-band transponders directed at Thailand and neighboring countries of South East Asia and will provide television, data and telephone service.
UNICOM	70° E	After 1995	Fixed Satellite Service	Unicom (see Table 2) is planning to place its second satellite at 70° E to serve the Asia-Europe market. The satellite may have C-band service to SE Asia-India, and Ku-band service to Japan/Korea/China and Europe.
NOTE	This table does not contain information on satellites from well established Asia-Pacific regional satellite services such as Asiasat 1, Inmarsat, and Intelsat, or domestic satellite services operating in Australia (Optus), China (DFH & Chinasat), India (Insat), Indonesia (Palapa), or Japan.			

Apstar has already leased 9 transponders on Apstar 1 to several U.S. based programmers, such as HBO, Turner, and ESPN, and an additional 16 transponders on a second satellite, Apstar 2.[11] The Apstar 1 satellite is intended to begin service before the Asiasat 2 satellite is launched in late 1994 but will have a smaller footprint than Asiasat 2. [12]

The second system is based on a new Russian satellite, Kupon. This system of four satellites is intended to interconnect Russian banks, but excess capacity is being leased to companies in both Asia and Europe. The satellite's operator has formed a partnership with a Philippine company in Manila, Communications and Broadcast Managers, Inc, to market transponders on a Kupon satellite and to provide domestic service to the Philippines.[13]

TABLE 4: Non-Geostationary Satellite Systems -- BIG LEOS

System	ARIES	ELLIPSO	GLOBALSTAR	IRIDIUM	ODYSSEY	Calling Network	INMARSAT
Operator	Constellation Communications	Ellipsat Corp.	Loral Cellular Systems, Corp.	Motorola Satellite Communications	TRW, Inc.	Calling Communications	See Table 1
Address Phone: Fax:	12530 Rosehaven St Suite 410 Fairfax, VA 22030 USA 1 (703) 352 1733 1 (703) 352 9279	1120 19th St. NW Suite 480 Washington, DC 20036 USA 1 (202) 466-4488 1 (202) 466-4493	600 Third Ave. 36th Floor New York, NY 10016 USA 1 (212) 697 1105 1 (212) 682 9805	1350 I St., NW Washington, DC 20005 USA 1 (202) 371-6880 1 (202) 842-0006	See Table 1 (Pacificom)	1900 West Garvey Ave. South Suite 200 West Covina, CA 91790 USA 1 (818) 856-0671 1 (818) 962-0758	See Table 1
Number of Satellites	48	24	48	66	12	840	Inmarsat is considering medium orbit and GEO systems. The decision on an Inmarsat system which will serve hand-held subscriber units is scheduled to be made in February 1994.
Orbit	Polar orbits; 550 nautical miles	63° inclined; elliptical orbit	52°inclined; 1389 Km high	polar orbits; 413 nautical miles	55° inclined; 10,354 Km high	98° inclined;	
Frequencies (U)	1624.5-1626.5	1610.5-1626.5	1610.5-1626.5	1610-1626.5	1610-1626.5	20-30 GHz (Ka-band)	
Frequencies (D)	2483.5-2500	2483.5-2500	2483.5-2500	1610-1626.5	2483.5-2500	same	
Type of Service	Voice-data-RDSS	Voice-data-RDSS	Voice-data-RDSS	Voice-data-RDSS	Voice-data-RDSS	Voice-data (up to 2 Mbps)	
FCC Status	Motorola and Loral petitioned the FCC to assign bandwidth as systems become operational. Constellation, Ellipsat and TRW presented their own plan to divide the spectrum into four segments and asked that the Motorola/Loral proposal be dismissed for procedural reasons.					No FCC applications on file	

3.4 PROGRESS ON ANNOUNCED SYSTEMS

PanAmSat, which is scheduled to launch its Pacific satellite, PanAmSat 2, in June 1994, raised $400 million to construct three satellites and signed a contract with Hughes for its 4th spacecraft. PanAmSat was unable to agree with Pacstar regarding the use of an orbital slot at 167.45° E, which both desired. PanAmSat therefore plans to move its satellite to 169° E to reduce interference with the Pacstar project.

Pacificom received a conditional FCC license for its first Pacific satellite. Pacificom will now begin coordination with Intelsat per section 14(d) of the Intelsat agreement.

3.5 PROGRESS ON EXISTING SYSTEMS

Columbia Communications revised its lease for the C-band channels of NASA's TDRS satellites and entered into a revenue sharing arrangement with NASA. The revised lease will assure that Columbia will have access to the TDRS satellites through 1998.

While Rimsat reached agreement with Palapa regarding the 134° E orbital location, two other satellite companies operating, or intending to operate GEO satellites in the Pacific--Columbia Communications and PanAmSat--have petitioned the Federal Communications Commission (FCC) and asked that the FCC not issue licenses to any United States earth stations that would access satellites in any of the Tongasat claimed slots, including 134° E. Rimsat is opposing the petition.

3.6 ORBITAL CONGESTION

The conflicting satellite plans of PanAmSat and Pacstar and of Tongasat and Palapa Pacific, which were previously mentioned, highlight the problem of competition for orbital slots in the Asia-Pacific region. A recent study found that two or more satellites have been proposed for over 20 orbital locations in the Asia-Pacific region.[14] Resolution of these conflicts will result in a delay or modification of many satellite proposals.

4. 1993 IN REVIEW -- BIG LEOS (LOW-EARTH ORBITING SYSTEMS)

Information on seven Big LEO systems is contained in Table 4.

4.1 FCC RULE MAKING ON BIG LEOS

The licensing of the Big LEO systems in the United States, those using frequencies above 1 GHz, is a major hurdle for the initiation of this service. To try to avoid a lengthy rulemaking procedure, the FCC asked applicants for mobile satellite systems to try to resolve multiple entry and band sharing issues using the bands 1610-1626.5 MHz and

2483.5-2500 MHz allocated by WARC-92 to Mobile Satellite Service (MSS). Six applicants or potential applicants agreed that they all can viably operate if they share the full-band spectrum. The seventh applicant, Motorola, believed that it can only operate in frequencies exclusively assigned to it.

Motorola and Globalstar then proposed a plan that the FCC divide the available bandwidth as satellite systems became operational. The other applicants oppose the Motorola/Globalstar proposal and request that the FCC divide the spectrum into four segments. Since the applicants could not resolve their issues, the FCC is expected to continue its rulemaking proceeding on licensing the LEO systems above 1 GHz.

4.2 NEW PROPOSED SYSTEM

Calling Communications Corporation proposed a system using LEO satellites operating in the Ka band frequencies (20-30 GHz) to provide worldwide telephone service. The system would be the largest proposed, requiring 840 LEO satellites (plus 84 spares). The Calling Network would provide switched digital connections up to 2 Mpbs, which would be sufficient to support ISDN connections. Applications for the Calling Network system are being prepared for filing at the Federal Communications Commission.

4.3 PROGRESS ON ANNOUNCED SYSTEMS

Several operators of proposed Big LEO systems announced progress regarding their systems.

Fairchild Space is building six spacecraft for the Ellipso system under an experimental FCC license.

Motorola announced $800 million dollars in initial financing for the Iridium system from an consortium of international companies including groups in Japan, the United States, Europe, and the operators of the Long March (China) and Proton (Russia) launch vehicles. Motorola also awarded a contract to Lockheed to construct the first 66 satellites and 14 spares by 1998.

Inmarsat announced that it had eliminated the consideration of LEO satellites for its proposed Inmarsat-P personal service. Inmarsat continues to study the use of GEO satellites as well as a configuration of satellite using medium orbits, similar to that proposed by the Odyssey project.

5. 1993 IN REVIEW -- LITTLE LEOS (LOW-EARTH ORBITING SYSTEMS)

Information on three Little LEO proposals is included in Table 5.

TABLE 5: Non-Geostationary Satellite Systems -- LITTLE LEOS

System	ORBCOMM	SAT/TRAC	STARNET
Operator	Orbital Communications Corp.	Energetics Satellite Corp.	Starsys, Inc.
Address Phone: Fax:	21700 Atlantic Blvd. Dulles, VA 20166 USA 1 (703) 406-6000 1 (703) 406-3504	1311 E. Briarwood Ave., Suite 300 Englewood, CO 80112, USA 1 (303) 790-7870 1 (303) 790-8525	4400 Forbes Blvd. Lanham, MD 20706 USA 1 (301) 459-8832 1 (301) 794-7106
# of Satellites	26	2	24
Orbit	45° inclined (24); polar orbit (2)	51° inclined;	50°-60° inclined; @ 1,300 Km
Frequencies (U) (MHz)	148-150.05	20-30 GHz	148-150.05
Frequencies (D) (MHz)	137-138 400.15-401	same	137-138 400.15-401
Type of Service	Data (2400 bps up, 4,800 bps down), 6-250 Bytes optimized--no maximum; location determination	Data, store and relay, location determination	Data (1,200 or 600 bps) short messages, location determination
Satellite Manufacturer	Orbital Microstar satellite	The SAT/TRACS LEO system is a precursor to the GEO system noted in Table 2.	To be determined
Launch Date and Vehicle	2 satellites on Orbital Pegasus rocket early in 1994, remainder in 1995		First launch 2 years after licensing with rapid build up to 6 satellite for initial capacity.

5.1 FCC LICENSING OF LITTLE LEOS

The applicants for the "Little LEO" applications agreed on technical parameters so their systems could operate without interference to each other. Soon the FCC is expected to publish final rules governing the Little LEOS satellite systems. Applicants will have 90 days to modify their applications to conform to the FCC rules.

5.2 LEO SATELLITES LAUNCHED

Orbcomm launched a demonstration satellite in February 1993 and conducted tests on the satellite leading to the final design of the system.

5.3 PROGRESS ON ANNOUNCED SYSTEMS

Orbcomm announced joint financing of the system with Teleglobe, Inc. of Montreal and also announced the final design of its satellites. After the launch of the first two Orbcomm satellites early in 1994, Orbcomm is expected to begin service to the United States.

5.4 ADDITIONAL LITTLE LEO SYSTEMS

Little LEO systems are relatively inexpensive to build and many small projects for data relay are underway around the world. Two US non-profit organizations, SateLife of Cambridge, Massachusetts, and Volunteers in Technical Assistance (VITA) of Arlington, Virginia, are operating small store and forward relay satellites for use in developing countries. Leo One Panamericana, a Mexican firm, has proposed a 12 satellite store and forward system for use in Latin America and other developing countries.[15] OHB-System of Bremen, Germany, was scheduled to launch its first Safir store and forward satellite late in 1993. If successful, this satellite will be followed by five others in a commercial system.[16] CNES, the French space agency, has tentatively decided to initiate a two-way messaging and position location satellite system. CNES has been operating an experimental satellite, S80-T, and expects to order 4 or 5 operational TAOS spacecraft. TAOS satellites will weigh 130 kg and be placed in orbits 1,300 km high.[17] Several Russian LEO systems are under consideration, including one developed from the operational Gonets satellite system.[18]

6. PREVIEW OF 1994

6.1 LAUNCHES SCHEDULED

The following satellite launches have been announced for 1994.

Date	Satellite	Launcher
Feb. 1994	Kupon	Proton
Early 1994	(2) Orbcomm	Pegasus
May 1994	PanAmSat	Ariane
June 1994	Express	Proton
This Express will be leased by Intelsat		
June 1994	Express	Proton
This Express will be leased by Rimsat		
July 1994	Apstar 1	Long March
July 1994	Intelsat 703	
August 1994	Kupon	Proton
Late 1994	Asiasat 2	Long March

6.2 NEW GEO SERVICES

A successful launch of the PanAmSat satellite in June 1994 will initiate a new service in the trans-Pacific region. Apstar will initiate a new service to the Asian region. Intelsat will expand its Asian-Pacific services using a leased Express satellite and the new Intelsat 7 series satellites. Additional Express launches to be placed in Rimsat (Tongasat) orbital slots could significantly add to the available transponders over the Pacific. The Russians are expected to begin service using the new Kupon (Globostar) satellites. Pacstar and Unicom may make announcements regarding their future plans which would bring additional services to the Pacific.

6.3 MOBILE SATELLITE SERVICES

Since the Little LEO applicants reached agreement on frequency sharing arrangements, the Federal Communications Commission is expected to issue licenses for the Little LEO mobile satellite services in 1994. Agreement on frequency sharing has not been reached by the Big LEO systems and the rule making and licensing proceedings will continue at the FCC.

Orbcomm expects to begin limited service to the United States from its first two satellites to be launched in 1994.

Inmarsat intends to select satellite technology for the Inmarsat-P service early in 1994.

American Mobile Satellite Corporation is scheduled to launch a Hughes geostationary satellite late in 1993 to provide mobile satellite service to the United States. Although this satellite will not serve the Pacific, the success of this service could influence the development of the proposed LEO services.

7. CONCLUSION

The satellite systems proposed will offer many opportunities for service in the Pacific, both in the short and long term. It is obvious from the interest displayed by current and new service providers that there will be distinct opportunities for the Pacific Islands and Pacific Rim countries to take advantage of advanced telecommunications systems. These telecommunications systems will be implemented as technical, regulatory and financial barriers are overcome. Users will be challenged to keep current with the rapidly changing Pacific satellite environment.

Endnotes

1. The view, opinions, and or conclusions presented in this report are those of the authors. They do not represent an official position of the National Telecommunications and Information Administration or of the U.S. Department of Commerce.

2. The authors would like to thank those current and proposed satellite operators who have provided information included in this report.

3 "Indonesia agrees to share 134° E orbital position to end dispute with Tonga," *Satellite Week* (November 8, 1993), p. 2.

4. Address given is for Pacific Satellite's attorney in the United States. Vice-President and General Manager Ms. Kim Degnan may be reached at 1 (612) 257-2806.

5. For recent description of Gorizont and Express satellites, see Robert Filep and Wilbur Pritchard, "The View from K-12 (Satellite City), Siberia," *Satellite Communications* (October and November, 1993).

6. "APT Satellite Co. to Award APSTAR 2 contract to Hughes," *Satellite News* (October 11, 1993), p. 7.

7. Scott Chase, "Indostar, Indonesia's Pioneering DAB/DBS System," *Via Satellite* (October 1993), p. 30-34.

8. Cynthia Broeke, "Another Russian Satellite Venture," *Via Satellite* (June 1993), p. 44.

9. *Cable and Satellite Europe* (Feb., 1993), p. 12.

10. Kevin Kuhns, "The Asian-Pacific Satellite Marketplace," *Via Satellite* (January 1993), p. 35.

11 "Seven TV firms sign pact to lease satellite in Asia," *The Wall Street Journal*, December 2, 1993, p. A11.

12. Patrick Seitz, "APT joins Asian Fray," *Space News* (August 16, 1993), p. 1.

13. *Cable and Satellite Europe* (Feb. 1993), p 12.

14. Kim Degnan, "Orbital settlers shoot it out with space outlaws--where is the sheriff?," *Via Satellite* (September, 1993), pp. 30-41.

15. "Leo One targets South American budget market," *Space News* (October 18, 1993), p. 18.

16. Peter de Selding, "Europe's light satellite production picks up speed," *Space News*, (August 23, 1993), p. 8.

17. Peter de Selding, "Taos work may start in early '94", *Space News* (September 27, 1993), p. 4.

18 For further discussion of possible Russian satellite systems, see Chris Bulloch, "Russat '93, A Catalog of Assets," *Via Satellite* (July 1993), p. 22.

SATELLITE SERVICES IN ASIA - AN UPDATE

ANDREW JORDAN, GENERAL MANAGER MARKETING, ASIASAT

1. Introduction

It would be something of an understatement to say that in the last 12 months since PTC 93 there have been a great number of developments in the satellite business in Asia. We have seen some new players emerge, others become more precarious, and a host of potential new alliances.

In this paper I would like to take a very broad and objective look at the state of the industry today, what the main services are, who the key players are, and what trends are most likely to stay. I will then present a few predictions of how the market is likely to develop over the next few years until the next century.

3. Current Services

A) Broadcasting

It is worth looking at broadcasting services first since, for the majority of satellite operators, these account for such a large percentage of capacity utilisation.

Domestic rebroadcasting

On AsiaSat we carry a number of domestic services, for countries as diverse as Mongolia, China, Pakistan and Burma. Each of these are very different, but all have in common a need to provide a basic television service to the whole of their populations, from the major cities to remote rural and mountainous areas. Before they began satellite transmission, their television programming was only available in the key population areas. Now they reach the whole of their countries.

They use their AsiaSat transponders for a terrestrial rebroadcasting service, where the television signal is uplinked to the satellite from a central earth station, and downlinked to a number of remote earth stations. From here the signal is converted into UHF or microwave and rebroadcast locally. The size of rebroadcast area varies according to the strength of the transmitter, depending on the number of people it is required to serve.

2. Historical Background

In our first PTC conference paper on the topic of satellite services in Asia at PTC 90, we felt it necessary to provide a rather detailed history of satellite development, starting with Early Bird, as a general illustration of the reasons why we were convinced that Asia was ready for satellites to play a major role in the development on many diverse infrastructures. AsiaSat 1 was designed from the outset as a regional satellite with a large and powerful footprint, on the basis that many countries needed satellite capacity but lacked the demand requirement or financial ability to launch their own satellites. At the time there were no dedicated regional satellites in Asia, and it is fair to say that we encountered a large degree of scepticism.

We launched AsiaSat 1 four months later, on April 7 1990, the first launch of an American satellite aboard a Chinese rocket, and the first privately owned regional satellite in Asia. At that time most industry pundits expressed an admiration for the entrepreneurial spirit of the AsiaSat shareholders, but at the same time few believed that the satellite would prove to be a commercial success.

Within 18 months of launch, however, the satellite was 100% fully leased, with more than 20 customers in 9 countries. 17 of the 24 transponders were leased for television broadcasting, and the remainder for telecommunications and radio. This is a feat virtually without parallel in the industry.

I mention this not to boast about AsiaSat's success, which has been well documented, but to illustrate the fact that the market exploded into life with the launch of AsiaSat 1. The principal reason for this is that there was - and still is - a tremendous suppressed demand in the region for improved telecommunications and broadcasting services. Let's take a look at why this is so.

STAR TV

We also carry STAR TV, a name familiar across the region as the first pan-Asian regional satellite television broadcaster. In just 2 years they have built up audience levels in excess of 50 million people, all watching sport, news, general entertainment, music and Chinese and Hindi language programmes.

Why has STAR been successful? First of all they were the first to enter the market, and as we have seen so often "the early bird catches the worm". Secondly, as the region becomes steadily more affluent, with more and more disposable income becoming available, there is a huge demand for entertainment programming. Asian viewers are no longer prepared to accept a television diet of lengthy shots of officials greeting foreign dignitaries, or presiding over the opening of new projects. This demand of course is barely satisfied by what is on offer today, and consumers can look forward to a vast array of programmes, more of which later in this paper.

Television distribution

Of STAR TV's estimated 50 million viewers (11 million households), perhaps 20% are being served by what we could define as true cable systems. The rest are receiving their programmes through SMATV, terrestrial rebroadcast or TVRO depending on individual environments. Hongkong, for example has a proliferation of SMATV systems, while in the Middle East TVROs are very popular. Currently there is no such thing as true DBS/DTH in Asia, but with the advent of the next generation of high powered hybrid satellites this will evolve over the next few years.

B) Telecommunications

The imagination of the general public has not, perhaps, been captured in quite the same way by telecommunications as by television broadcasting. However, satellites are playing a crucial role in the development and enhancement of communications infrastructures in an increasing number of countries in this region. AsiaSat, for example, have several VSAT customers in China, Mongolia, Hongkong, Malaysia, Thailand, Pakistan, Burma and the Middle East. These include both PTTs expanding their national domestic services, as well as licensed private operators in several countries.

A good example of a private carrier is Compunet in Thailand, who have a concession for a private VSAT based Data network. Using a 7.5 metre central hub near Bangkok, they provide 2 way communications via AsiaSat 1 to more than 350 remote sites throughout Thailand each using 2 metre antennae. Their customers include major banks, hotels, manufacturers and stockbrokers.

4 Satellite service providers

Although AsiaSat is, perhaps, the best known of the current service providers, there are of course other satellite companies offering or proposing to offer services. Let's take a brief look at some of these starting with those that we believe will offer the strongest regional competition.

Intelsat

Of these the largest is Intelsat, who continue to provide a global service begun more than two decades ago. While they continue to suffer a shortage of capacity, they are working at becoming more responsive to the market in the face of competition from private satellites, known as "separate systems". This year they intend to begin utilising Russian Express satellites in what they have termed "Landmass" services, and they can soon look forward to the launch of the first of the Intelsat 7 series of satellites. We expect them to become a more formidable competitor, although we believe the bulk of their demand will continue to come from bulk trunk and thin route telephony.

Palapa

Palapa are a well known company who have been offering domestic services to Indonesia and limited regional coverage primarily of the ASEAN region of S.E. Asia. They have three geostationary satellites, B1, B2P and B2R, and links through associate companies to an inclined orbit satellite known as Palapa Pasifik. Since the advent of AsiaSat and STAR TV they have attracted a number of international television broadcasters, including CNN, ESPN, HBO, TVB, ATVI (members of the so-called "Gang of Five" consortium) but the programming is not as yet widely available. In 1996 they will be launching the first of their hybrid C series satellites, higher powered and with much greater regional coverage than the current generation.

APT

Asia Pacific Telecommunications Satellite Company is a fairly new entrant to the market, and although a Hongkong registered company, is owned by a number of companies controlled by Peoples Republic of China government agencies, as well as Singapore Telecom and Chia Tai of Thailand. They plan to launch Apstar 1, their first satellite, in mid 1994. The satellite, a 24 C-Band transponder Hughes HS376 is currently under construction. There have been a number of announcements of Apstar 2, which is claimed to be a high powered hybrid satellite, but as yet no contract has been signed with any manufacturer. Recently the Gang of Five signed reservations agreements for Apstar 1 transponders which will reach from China to South East Asia.

5. Orbital Arc Congestion

Some of these will succeed, while others will remain simply concepts. There are a number of reasons for this, most notably the very heavy capital expenditure required to launch a satellite, years in advance of the first revenue streams. Secondly, there is the increasing problem of orbital arc congestion.

I have spoken at length on this subject in the past, and indeed one of my colleagues is presenting a separate paper exclusively on this topic. I will therefore limit my comments to a basic summary of the facts. C-Band satellites are recommended by the CCIR to be spaced at least 2.5° apart, to avoid interference from adjacent satellites.

The publicity generated by the market for satellite broadcasting, in particular, has as we have seen above encouraged a number of organizations to announce plans to enter the market. Unfortunately there is not enough space to accommodate everybody, and this has led to several instances of orbital slot disputes, with a disturbing trend emerging of some companies claiming that because they will launch first, they have first rights to a slot. In other words squatters rights.

This has led to an erroneous belief that orbital slots are commodities which can be traded or leased at will to other operators. This threatens that fabric of the ITU coordination process, and we believe that it is time for the rules to be streamlined. My colleagues will make various proposals, which include a reduction in the number of slots a company can file for before a successful launch, a reduction in the period a slot can be considered protected if unoccupied (currently 9 years), and a refusal by the ITU to accept multiple filings which cause interference to prior filings.

6. The future

To sum up the situation today, we have a growing market, with more services planned and ground consumers being promised perhaps as many as 500 television programmes to choose from in the future. Most of today's broadcasters, while promising to continue free to air services, appear to be pinning their hopes on subscription television, including video on demand, home shopping, educational and what is known as "infotainment" programming.

Digital Video Compression will increase greatly the number of television channels which can be carried by on transponder, so although there will continue to be a shortage of supply in terms of transponder capacity, technological advances such as these will ensure that supply will actually increase in terms of programmes available.

An efficient distribution network will be crucial to the success of this type of programming, which will be distributed regionally via satellite, in many cases direct to home as dish sizes become ever smaller with higher powers and digital transmission. Increasingly fibre optic cable will lay a more and more important role, particularly for interactive television, but will be entirely complimentary to satellites.

PanAmSat

A private US company, Pan American Satellite currently operates PAS 1 over the Atlantic ocean, providing services to North and South America and Europe. The GE built satellite is operating at full capacity, with ambitious plans to launch three more satellites over the next 2 years. Each will be a Hughes HS 601 hybrid spacecraft, and they are intended to provide global coverage, at substantially higher powers than are offered by Intelsat. PanAmSat's likely customers include telecom organizations and broadcasters, primarily for long distance distribution and backhaul.

Other international operators include Columbia, offering services today at Intelsat power levels.

Let's now take a look at some of the national domestic satellites which have proliferated in the last couple of years.

Thaicom

Thaicom will launch two Hughes HS 376 satellites, each with 10 C and 2 Ku-Band transponders, to be co-located at 78.5° East, following a breakthrough in a major dispute with AsiaSat over orbital slot priority. This topic will be dealt with in further detail below. Both satellites will primarily serve the large market for domestic satellite communications, and we also anticipate that Thaicom will make a major effort to position itself as an emerging hub for the nations of Indochina.

Japan

Despite a very serious glut of Ku-Band capacity in Japan, currently in excess of 100 transponders, more satellites are planned. We expect that some of these will included some form of C-Band regional payload, although coordination difficulties are likely to occur for most Japanese orbital slots. We have recently seen several mergers in the industry in Japan, for example between Japan Communications Satellite (JCSat) and Satellite Japan Corp (Sajac).

Optus

Formerly Aussat, Optus is the second domestic telecommunications carrier in Australia, as well as operator of the national domestic satellite. Optus satellites are used by for both television and telecommunications. It is intended to be the method of delivery of Australia's proposed Pay TV services, as and when these start.

Koreasat

Two satellites are currently being manufactured by Martin Marietta, each high powered Ku-Band with footprints covering the Korean peninsula.

Broadcasters will need to pay close attention to the cost and availability of ground equipment required to receive and decode the signals, and equally importantly, they must address the question of how to collect payment in a large number of different countries each with their own different regulatory climate. Solutions will of course be found.

The market will not just be for international broadcasters; a number of regional television organizations will, we believe, become major players who will build audiences outside of their current home territories.

In addition to large regional footprints, we will see some consolidation and, as a result, fragmentation of the market. The result of this will be specific footprints targetted at certain key markets, in Ku and possibly other bandwidths as the C-Band spectrum becomes fully utilised.

We are also likely to see a number of mergers and takeovers, both among the programmers and the satellite operators themselves, as alliances shift and markets develop.

In the telecommunications market we anticipate a major growth in the VSAT business, particularly for smaller users as markets continue, albeit slowly, to deregulate. Although the much talked about cross border VSAT business faces a number of obstacles, chiefly regulatory, we envisage a healthy business developing for these type of networks within the next 5 years.

China

The MPT recently purchased the ageing Spacenet 2 satellite from GTE Spacenet, which has been drifted to a new orbital position of 115° East, although it is not yet believed to be coordinated with adjacent satellites. The DFH 3 series satellite, built in China, has been delayed by several years, and industry opinion is divided as to when precisely this satellite will be launched.

A number of other countries in the region have announced plans, although the majority are little more than feasibility studies. MEASAT, the proposed Malaysian East Asian Satellite remains just a concept, despite a certain amount of fanfare surrounding its initial announcement at Telecom 91.

7. Conclusion

We see a very strong role for satellites continuing into the next century, complimented by improvements in related technologies. Satellites will continue to play a major role in the development and increasing sophistication of national and international communications infrastructures in the region.

What PanAmSat Has Accomplished and Where We're Headed

Fred Landman
President and Chief Operating Officer
PanAmSat
Greenwich, Ct. USA

Less than 10 years ago, PanAmSat was an upstart private international satellite venture that faced myriad regulatory and market hurdles. Now, our company is a profitable satellite service provider that has virtually sold out capacity on its first satellite and in December 1993 announced nearly US $1 billion in service agreements on three new satellites. Over the next 15 months, PanAmSat will launch the new satellites and become the first private, global satellite service provider. This paper provides an in-depth overview of the path that PanAmSat has taken to become the first private international satellite service provider and our ambitious plans to make its services available to 98 percent of the world's population.

CREATING PANAMSAT

In the early 1970s, the U.S. government instituted an "open skies" policy that permitted private competition for domestic satellite services. This policy fostered the creation of a dynamic market in which several domestic satellite operators provide competitive services in response to customer demands.

In 1984, U.S. President Ronald Reagan signed a directive stating that private international satellite systems competing with Intelsat are in the U.S. national interest. In effect, Reagan expanded that open skies philosophy to the international arena, which was dominated by the intergovernmental monopoly.

Rene Anselmo, a former broadcaster and PanAmSat's founder and chairman, experienced first-hand the expensive, time-consuming and monopoly-driven procedures required to obtain international satellite capacity through the Intelsat system. Broadcasters and companies seeking private business networks faced a litany of abuses: services in which the needs of the

PanAmSat's founder and chairman, experienced first-hand the expensive, time-consuming and monopoly-driven procedures required to obtain international satellite capacity through the Intelsat system. Broadcasters and companies seeking private business networks faced a litany of abuses: services in which the needs of the

signatory, not the customer, are paramount; the requirement to pay separate uplink and downlink charges; the unconscionable neglect of developing markets like Latin America; and high prices for low-power satellite capacity. As a result, PanAmSat was founded in 1984 to launch the first private international satellite over the Atlantic Ocean Region and offer high-quality services directly to broadcasters and other customers.

Intelsat and its signatory balked at the idea of facing competition and declared a boycott against all private international satellites. Intelsat and its PTT members, including the U.S. signatory Comsat, started an ongoing campaign to maintain the Intelsat monopoly and stifle competition.

In June 1988, an Ariane 4 rocket launched the PAS-1 satellite, a GE Series 3000 satellite with 18 C-band and 6 Ku-band transponders. At the time of launch, PanAmSat only had regulatory approval to provide service between the United States and Peru. The company had no customers.

BUILDING A CUSTOMER BASE OF PAS-1

Despite Intelsat boycotts and regulatory barriers, PanAmSat had the resources for success: superior satellite services available directly to customers and a first-hand understanding of the needs of broadcasters. PanAmSat undertook an aggressive marketing and regulatory effort that enabled the company to generate a growing customer base and chip away at regulatory barriers. CNN was the first international broadcaster to sign a long-term lease for PanAmSat capacity.

Today, PanAmSat provides service on the PAS-1 satellite to more than 250 customers in some 70 countries. Broadcast customers, which have contracts representing about two-thirds of PanAmSat's revenues, include the well-known broadcasters HBO, Turner Broadcasting, NHK, CBS, NBC, Fox and MTV plus regional broadcasters Peruvian channels 2, 4, 5 and 13, TVN and Telefe. Digital network customers include Reuters, Citicorp, Sara Lee and Banco del Pacifico, Equador's largest bank. The PAS-1 satellite is virtually sold out.

PanAmSat tailors its services to the broadcast and digital network markets and also provides capacity for thin-route telephony. Broadcasters use PanAmsat satellites for a range of purposes: distribution of programming from a broadcast headquarters to local cable companies, local television stations and households; transmission of programming segments or news reports back to the broadcast headquarters; and special events and live news coverage that require rapid, previously unforeseen access to satellite capacity.

In a continuing effort to provide new and better services, PanAmSat has introduced many new services to the international satellite market. For instance, PanAmSat is the first international satellite operator to provide compressed digital video services. Because of high demand and PAS-1 capacity constraints, PanAmSat now is transmitting one CDV channel each for MTV, NBC News, TV-5, Fox, Cinecanal and USA over a transponder that previously carried one analog channel.

For its digital networks customers, PanAmSat provides satellite capacity to national and regional carriers that set up private networks for businesses. PanAmSat also provides end-to-end services directly for businesses. In these instances, PanAmSat is responsible for all network components, from satellite capacity to earth stations and teleport services.

PanAmSat's greatest appeal is that it is a private company focused exclusively on the customer. The company has earned a reputation for:

- open direct access to its satellite services without middlemen who mark up prices or limit the types of services offered;

- high-quality transmissions at cost-effective prices;

- the resources to provide end-to-end services, including earth station and other equipment for satellite communications networks;

- profitable, customer-oriented operations.

While PanAmSat has created a successful business, it is unwilling to accept the unfair and underhanded tactics of Intelsat and its signatories. As a result, PanAmSat filed an antitrust lawsuit against Comsat in 1989 seeking $1.5 billion in damages. PanAmSat contends that Comsat has undertaken anticompetitive conduct that has prevented or delayed PanAmSat's entry into various markets. The U.S. District Court in New York has allowed the lawsuit to proceed as it relates to Comsat's actions that are not shielded by immunity as the U.S. signatory to Intelsat. We now are in the discovery phase of the case.

MOVING FORWARD WITH THE PAS GLOBAL SATELLITE SYSTEM

Based on our market experience with PAS-1 and the future requirements expressed by customers, PanAmSat decided to move forward with global expansion plans. The company selected Hughes Aircraft Co. to build three new HS 601 satellites and Arianespace to launch each satellite from French Guiana. Hughes also will build a ground spare that can be ready for launch in 11 months.

PanAmSat selected the HS 601 design because of its exceptional operating power, which translates into very high transmission power levels (and therefore smaller, less expensive earth stations) on the ground. Each satellite will contain 16 54MHz C-band transponders, powered with 34 watt SSPAs, and 16 54MHz Ku-band transponders, powered by 63 watt TWTAs. C-band power levels will be up to 38 dBW, which means customers can use earth stations as small as 1.8 meters in diameter on the ground. Ku-band power levels will be up to 51 dBW, which translates into 60-90 cm. antennas for customers -- an optimal size for direct-to-home television service and other applications. Each satellite employs new beam shaping technology, which focuses the distribution of power over key centers of population and economic activity.

Arianespace was selected for its high launch reliability and ability to meet PanAmSat's aggressive launch schedule:

Satellite	Ocean Region	Orbital Slot	Launch Date
PAS-2	Pacific	191°WL	May 1994
PAS-3	Atlantic	43°WL	Nov.-Dec. 1994
PAS-4	Indian	68°/72°EL	March-May 1995

The PAS-2 satellite will provide service in the Pacific Ocean Region. Its C-band coverage will reach from California throughout Asia, while Ku-band beams will concentrate high transmission power in China, Australia/New Zealand and North East Asia. PAS-3 will serve the Americas and Europe as well as introduce PanAmSat services to Africa. PAS-4 will provide transmission links between Tokyo and Paris on one satellite hop.

PanAmSat also will build regional teleports in addition to its current Atlantic Ocean Region facility in Homestead, Fla. Teleports are planned for California to provide PAS-2 services; Asia for PAS-2 and PAS-4 services; and Europe for PAS-1, PAS-3 and PAS-4 services.

One of the biggest hurdles facing entrepreneurial satellite ventures is financing the huge costs to build, launch and operate satellites. Over the past year, PanAmSat has raised US $640 million to complete the financing of the PAS Global Satellite System. The company's US $440 million bond offering, complete in August 1993, was one of the largest high-yield offerings of 1993 and a milestone in the financing for U.S. satellite ventures.

OFFERING GLOBAL SERVICES

While construction and launch of the new satellites are exciting, PanAmSat ultimately is focused on offering services that have major benefits to broadcasters and businesses using private communications networks. In general, PanAmSat has opted for focused, high-power C-band and Ku-band capacity to keep customer earth station costs as low as possible. At the same time, the satellites provide transoceanic reach in C-band and focused power in Ku-band.

The new PanAmSat satellites offer broadcasters many options for domestic, regional and international services. Consider the advantages of PAS-2, which will offer service in the Pacific Ocean Region by June 1994:

- Program distribution over one C-band beam from California to cable headends, local broadcast networks or two-meter TVROs throughout the Pacific Rim.
- Program distribution from California or Asia directly to households with 60-90 centimeter antennas over a Ku-band spot beam in China, Australia or Northeast Asia.
- Program distribution from Asia to California over one C-band beam for redistribution to U.S. and Canadian households.
- Program distribution over one C-band beam to virtually all Pacific islands, including the Philippines and Taiwan.
- Satellite news gathering from Asia using 1.2 meter flyaways in Ku-band and 1.8 meter flyaways in C-band as part of a global digital SNG service offered on the PAS satellites.
- Compressed digital video services that enable broadcasters to transmit six channels of digital programming over one transponder.

The PAS-2 satellite also will enable companies to install private data and voice networks among multiple sites in Asia using 0.9-1.8 meter antennas in Ku-band and 2.4 meter antennas in C-band. In addition, the satellite offers the opportunity for telephony carriers to lease high-power satellite capacity and provide telephony services in remote areas that have poor communications infrastructures or cannot support the cost of large Intelsat gateway earth stations.

The service advantages of PanAmSat's new satellites already are generating the same kind of market response worldwide that PAS-1 has received in the Atlantic Ocean Region. As of December 1993, PanAmSat had garnered close to $1 billion in agreements to provide service on the new satellites. Broadcasters that have entered into long-term agreements include Turner Broadcasting, ESPN, and the Philippines' ABS-CBN Broadcasting Corp.

In addition, PanAmSat won a hotly competed contract in mid-1993 to provide Ku-band service for South African broadcasters. SABC/SENTECH and MNET selected PanAmSat over Intelsat and a European consortium because of the superior performance and competitive pricing of our PAS-4 satellite.

CONCLUSIONS

PanAmSat has become a successful international satellite operator by providing broadcasters and other users direct access to our high-power satellite services and a range of service innovations. PAS-1 introduced superior, private satellite services to the Atlantic Ocean Region, and the new HS 601 satellites will expand our services worldwide.

PanAmSat looks forward to serving the Pacific Ocean Region in less than six months and offering global service in 1-1/2 years.

GLOBAL SATELLITE SYSTEM FACT SHEET

Manufacturer:	Hughes Aircraft Company
Satellite:	HS 601
Operating Design Life:	15 years
Estimated Lift-Off Weight:	6,400 pounds

Satellite	**Ocean Region**	**Orbital Location**	**Delivery Date**
PAS -1*	Atlantic	45° WL / 315° EL	In Orbit
PAS-2	Pacific	191° WL / 169° EL	March 1994
PAS-3	Atlantic	43° WL / 317° EL	November 1994
PAS-4	Indian	292°/ 288° WL / 68°/ 72° EL**	February 1995

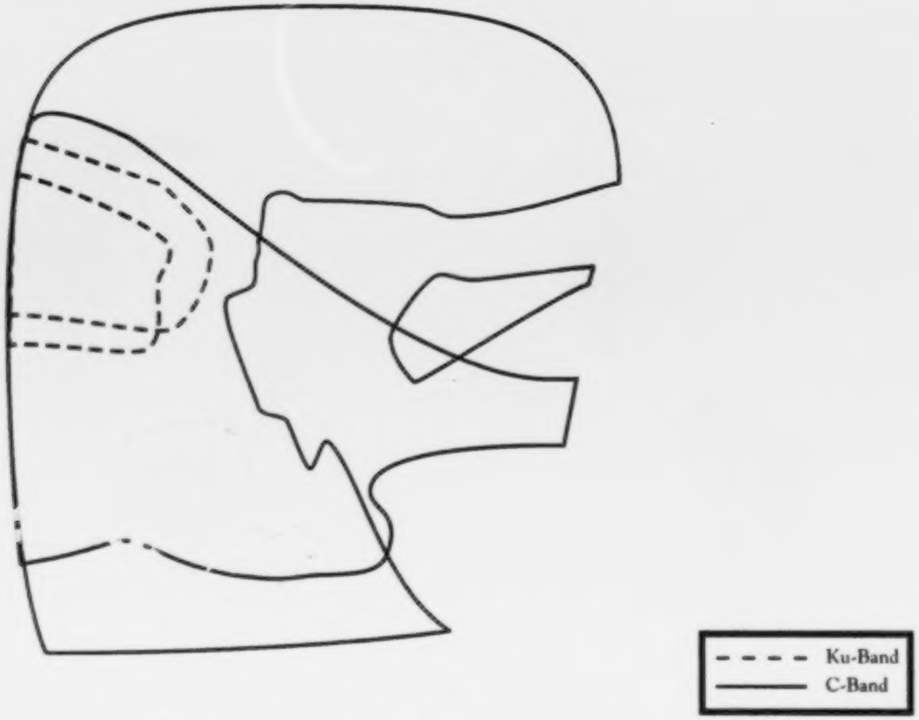
*GE Astro Series 3000

**PanAmSat is registered for both orbital locations

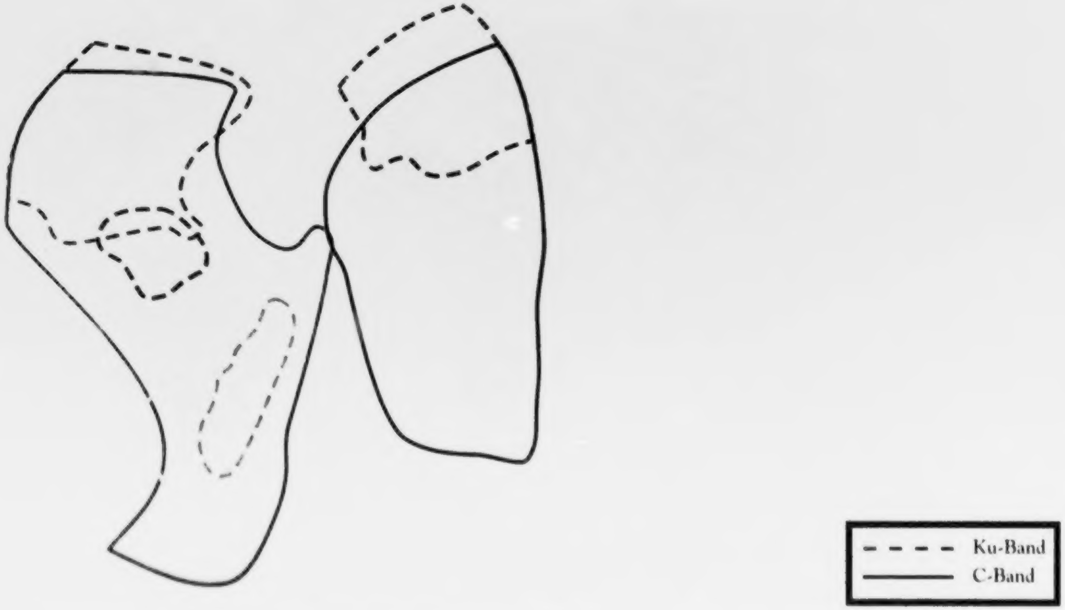
	Ku-Band	**C-Band**
Transponders:	16 x 54 MHz	16 x 54 MHz
Cross-Strapping Capability:	8 Transponders Ku to C	8 Transponders C to Ku
Transponder Output Power:	63 Watt	34 Watt

PanAmSat

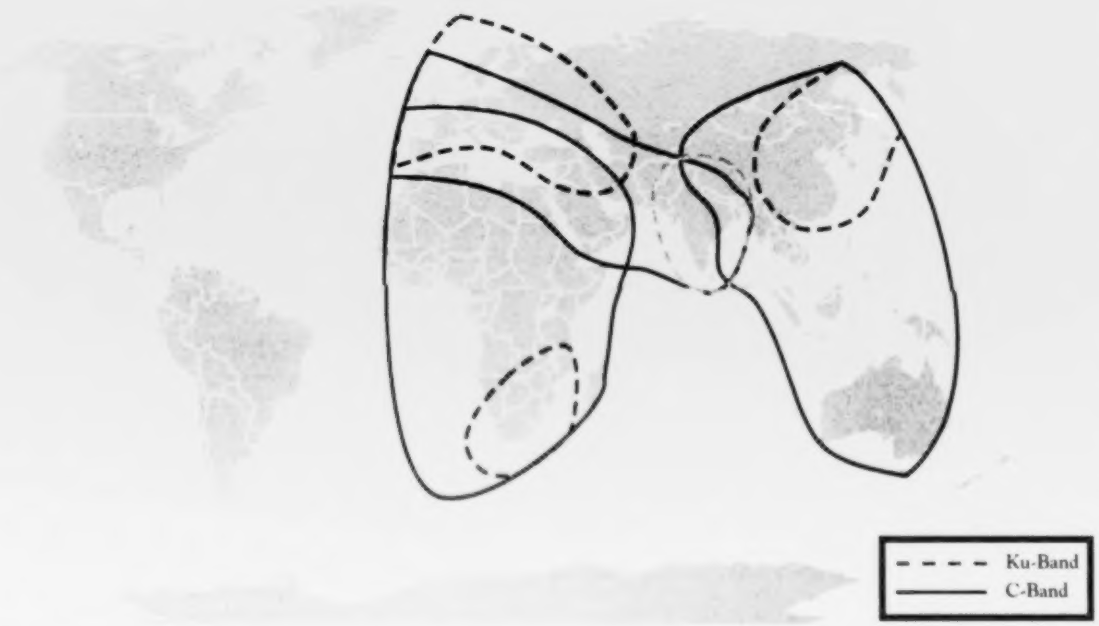
PAS-2


Ku-Band
C-Band

PAS-3


Ku-Band
C-Band

PAS-4


Ku-Band
C-Band

New Links to be Forged:
Data services for Pacific Island Nations

by Daniel C. Smith
Air Marshall Islands[1]
Majuro, Marshall Islands

1. Abstract

The data telecom needs of Pacific Island nations are described and ordered in increasing bandwidth from customer perspectives. While data services lag behind phone services several cooperative approaches to providing modern yet cost-effective data services on thin routes are discussed.

2. Missing Data Links

While great strides have been made in recent years in international telephony in the Central and South Pacific, data services remain limited and expensive. This relative neglect of data is understandable in light of the high, and generally successful, level of effort necessary to extend plain old telephone service (POTS) to the urban centers. We believe that a link that deserves particular attention is the extension of basic data services to each community simultaneously with the delivery of POTS to every household. This goal is very realistic because the new systems are entirely digital at their core. We do not mean to suggest that digital services will be delivered to each household, but that digital services will be available in each community for use by businesses and other important users such as schools and hospitals.

The challenge for those who guide social investment will be to make sure that data requirements are not neglected. For countries to become competitive their telecom offerings must go beyond POTS, however great the penetration. The demand for data has been mitigated to some extent by the FAX machine but computer communication services lag far behind in comparison to the sophisticated digital switches and transmission facilities being installed for POTS.

Fortunately the problems of the rural areas of Pacific Island nations are similar to those of rural areas of developed countries. Our hypothesis is that the many of the same goals and solutions apply. One of the goals is to help develop the rural areas to reduce the rate of rural-urban migration. Another goal is to facilitate the extension of social services on a a more equal basis with the urban areas.

On the solution side, rural Pacific Islands will not require less advanced services (except at the high end) than say Pacific Rim countries, but rather the same sophistication but in smaller quantities. Part of this 'same sophistication' concept is the idea that there is no single data solution for all applications. Thus we will argue that a readily available mix of data solutions should include leased lines, public switched data networks (PSDN), and ISDN. Leased lines and the PSDN have a symbiotic relationship which will be explained below and which can be implemented quickly. ISDN has a different set of applications but the necessary infrastructure is increasingly available and should be exploited.

The data problems of Pacific Islands are in some ways like those of remote corporate offices in developed countries. " . . . PC LAN users are stuck in remote sites that are often tethered to the corporate LAN by the thinnest dial-up links. Lacking the technical staff to support complex, multi-protocol LAN/WAN internetworking, users at any but the largest remote sites have been relegated to second-class status."[2]

In the spirit of the Maitland Commission report,[3] we assert that a missing link for Pacific Islands is a balanced set of data alternatives which will help these countries from slipping into second-class status.

3. Needs

3.1 Data the Pacific Way

The following classification of frequent data users in Pacific Islands is proposed:

A. Leased line and PSDN -- urban areas
    1. Low volume replacements for the telex -- i.e. E-Mail.
    2. Transactional systems -- banking (including credit card processing) and the travel industry.
    3. Academic and commercial users of the INTERNET.
    4. Personal and business users of information utilities such as Compuserve, WestLaw, Dow Jones, to name a few.

B. PSTN
    1. FAX, file transfer, and domestic connection to the PSDN
    2. International dialup --including use of the DAMA network
C. Basic Rate ISDN (2B+D)
    1. Distance education.
    2. Medical conferencing.
D. High bandwidth Applications including PRI-ISDN
    1. Compressed TV
    2. Full motion conferencing
    3. CAD/CAM, military

3.2 Leased Lines and PSDN

Leased lines and the PSDN have a symbiotic relationship because in small markets they can be multiplexed onto the same bearer channel making them affordable. Leased lines serve the needs of customers who use proprietary protocols, believe they face security threats, or have relatively high volumes of traffic and wish to escape per minute or per character charges. In the cases of banks and airlines they need relatively low volume but high priority transactional services to fixed locations.

The PSDN can serve those running open protocols such as X.25 and TCP/IP for connection to commercial information utilities, messaging, and INTERNET services.

The INTERNET deserves special mention because the lack of an affordable connection to the INTERNET by the higher educational institutions in a country is a marker for underdevelopment. The INTERNET is an important means for academic and government leaders to actively participate in debate on major scientific questions such as global warming.

Scientific advisory bodies in the United Nations have noted that the most effective step governments in developing countries could take in fostering their scientific and technical communities would be investment in information, communication and transportation facilities.[4]

This Spring the Commission on Science and Technology urged the U.N. and individual developing countries to develop affordable access to the INTERNET.[5] While connections to the INTERNET are high speed at universities in the developed world, effective, shared connections at 9.6 kbps are realistic for small college campuses in the Pacific. Most college campuses and extension centers in the Pacific have a part-time, one-computer connection to INTERNET e-mail services through PEACESAT.

The commercialization of the INTERNET is a development that island nations can benefit from but in the interim there are many not-for-profit activities and projects that would be facilitated by affordable access to the INTERNET.

Multiplexing of data from various customers is an effective solution when single channel per carrier circuits are used to smaller countries. As these countries move to digital bearer channels for their major connections, our plea would be that data customers be considered in the initial design so that the necessary hardware and software for data services are ordered with the equipment for voice services.

3.3 PSTN

The PSTN will serve the needs of FAX transmission and the occasional transfer of files. In addition, affordable domestic PSTN connections will provide rural users with connection the the PSDN.

3.4 ISDN --Basic Rate Access (2B+D)

Some will challenge the idea that ISDN is a priority need for Pacific Islands. On the contrary, even ISDN can serve the need for distance learning and medical consultation.[6] We see ISDN as the appropriate technology to provide random, relatively high bandwidth connections to various locations.

The U.S. Rural Electrification Administration has a program to encourage innovative telecommunications applications in rural areas, specifically in the areas of medicine and education.[7] ISDN fits the bill.

3.5 Cost independence from distance

A local phone or data call will cost less than an overseas one but the large disparity between domestic and international telecom prices --even over the same satellite -- discourages business and trade. Reduction of distance related charges is important to scattered islands.

4. Solutions

4.1 Dialup Data Contrasted with Shared Data Services

Before beginning this discussion, I want to emphasize my admiration and respect for OTC/Telstra's DAMA voice service. It is a puzzle to us why the service is not more utilized in the Islands, and why a U.S. long distance carrier has not established a connection.

As a data customer we have reservations about the July 1992 proposal[8] of Australia's OTC (now Telstra) for demand data service (now called DAMA-NET) via the PACT network. Review of some of its apparent features shows why a conventional PSDN's and ISDN remain attractive alternatives.

The proposal, aimed at potential customers such as the Forum Fisheries Agency and airlines, lists customer rates of A$0.74 to 0.52 per minute for minima of 2,500 to 10,000 minutes per month of 4,800 bps dialup connection. (The new digital connections will run significantly faster.) This contrasts with voice rates of typically A$3/minute. There are indications however that governments (PTT's) will lower end minute rates in the near future. The advantage for the large data customer is that in exchange for a minimum payment of $A1,835 per month substantially lower rates can be obtained.

The large volume customers, particularly banks and airlines, have traditionally leased full-time analog lines (at 13 cents per minute, and lower) for their requirements. However the increased availability of inexpensive bandwidth-on-demand at low prices will encourage a return to public data networks. In our view the PACT proposal is a significant marketing initiative but not an approach which has inherently lower prices because of efficient use of bandwidth.

Banks and airlines (the travel industry) tend to be online during the whole business day and in the case of an airline flying seven days a week, 24 hours per day. At those usage levels the traditional leased line, or a modern shared line would cost far less. We know this to be the case as full-time leased 2,400 bps bandwidth through sharing (and the 2,400 is to be further shared) is available at about A$2,600 per month from Australia precisely to islands where it is proposed to utilize the Telstra DAMA NET idea. There are firm indications that other countries will also make available attractively-priced leased/shared data bandwidth available. (The end-to-end space segment digital voice circuit cost from INTELSAT is on the order of US$1,000 per month -- less on a long-term lease -- and telco's mark it up 200 - 500% depending on how they view their capital costs and their values about how much the business customer should subsidize residential customers.)

As an airline customer I would much rather pay A$2,600 per month for 2.4kbps 24 hours per day seven days per week than A$1,835 per month for 2 hours per business day because the cost could go much higher if usage increased to over two hours per business day. The PACT proposal would be more attractive if it offered off-peak pricing.

The fundamental reasons DAMA NET proposal is unattractive is that (1) the typical Pacific Island airline must buy more bandwidth than is needed, and (2) the installed base of airline equipment and software is set up for dedicated leased lines.

Consider a typical Air Marshall Islands cluster of reservation terminals. Assuming all the 9 million characters per month are moved during 21 business days of 8 hours each, the average data rate is 893 characters per **minute.** (A typical entry is 17 characters and the typical response from the mainframe host is 149 characters.) Clearly 2,400 bps is more than adequate but DAMA NET requires one to pay for capacity six times that at three to four times the price.

Another concern is that the setup time would be very annoying to airline staff if they had to wait each time the connection was reestablished.

4.2 Shared Leased Lines

Airlines have a long history of sharing communication services while competing in selling seats. Sharing resources is part of the 'Pacific Way.' A central point of this paper is that sharing of data circuits is the speedy and affordable way to bring new data services to island urban centers.

Thus I believe the airline telecom community should devote its energies and resources toward encouraging and/or providing, in cooperation with Pacific Island PTT's, public or quasi-public data services. The topology initially would be a star -- or several stars -- with hub(s) in cities such as Sydney, Auckland, Los Angeles, Singapore, and Tokyo.[9] Connections can be established quickly using airline link code (ALC) protocols and multiplexing on existing circuits, especially those for telex, and rapidly move to circuit sharing via X.25 and frame relay protocols. The countries and the PTT's can provide extra services and connectivity for their customers by encouraging OSI protocols. Airlines, even ones using different ALC protocols, can share X.25 links with PC and software combinations costing about US$5-11K per end.[10]

The hub many Pacific airlines need now is in Sydney. The island capitals do not need the dialup to Sydney; they need sharing of under-utilized existing data bandwidth. However data via DAMA can play an important role in providing overflow bandwidth during peaks in the business day. The simple packet switches necessary to do this are not expensive and they can also store messages, eliminating one of the airline host computer problems with dialup. (The other one is security which a data network could enhance compared to direct dialup.)

Brief domestic dial up data, even at the full voice rate, will be attractive for more remote islands in the PACT network. The approach would be a modification of the old teletype reservations request procedure. However the requests would formatted and checked by a PC and batched in. As most administrations are moving toward one

700

minute minima, such a service could cost only a few dollars per day.

The important exception to our reservations on "Data by DAMA" would be if in ordering your connection you could request a bandwidth. For example instead of the capacity defaulting to 14,400 bps, one could request 1,200 then the cost could be quite attractive. If this bandwidth on demand were to go up to basic rate ISDN then virtually all data requirements of Pacific Island countries would be met.

Implementation would require that the modems, in addition to being frequency agile, would have to be rate-agile. Rate (bandwidth)-agile modems are available.

The data model we see as beneficial is illustrated below as Figure 1.

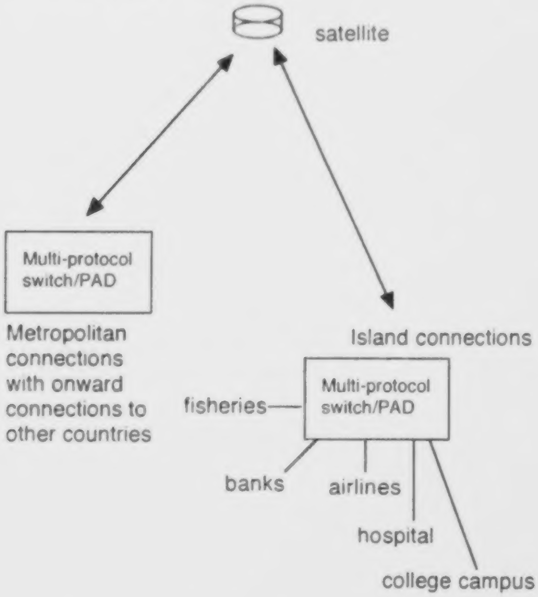

satellite
Multi-protocol switch/PAD
Metropolitan connections with onward connections to other countries
Island connections
Multi-protocol switch/PAD
fisheries
banks
airlines
hospital
college campus

Figure 1. Shared Data Service Model

We believe that the attractiveness of a shared service is entirely compatible with the DAMA concept provided the software in the routers were modified to release the channel when there was no traffic for a period. This would likely happen at night. When traffic resumed, the router would buffer the traffic until the DAMA system could reestablish the connection.

Our recommendation of increasing shared data services can be achieved by regional efforts in line with recommendation 24 of the Maitland Commission on pooled purchasing. None of the equipment that needs to be purchased is very expensive but the development may be beyond any one customer.

Our airline is not simply being altruistic in promoting shared services. We believe there are direct benefits such as lower costs by more efficient use of the channel, and there a long-term indirect benefits from improvements in education (airline people must have recurrent training, for example), health care, and stronger businesses.

Shared services must be efficient. We are not suggesting shared service as a public relations stunt. We remove our traffic from SITA, the airline communication coop, if we can do better on our own.

The standard old airline protocols are extremely wasteful of a satellite circuit because they are modulo two -- only one packet is on the link at any given time -- , polled, and use a channel with more capacity than is needed. More efficient protocols (even allowing for the overhead of acknowledgements) such as X.25 or SDLC typically are modulo 128 thus a number of packets can be in transit. Frame relay solutions would increase the efficiency even more by eliminating acknowledgement overhead.

Airlines have no choice but to buy data communication services. And unfortunately we don't have much time or money for R&D. Therefore we use our old 'tried and true' solutions even if they are relatively inefficient. On the other hand with the telco's, regional universities, the local college campus, other businesses, and some regional assistance (modest monetarily but significant intellectually) solutions can be assembled which will will allow airlines to facilitate affordable data connections to colleges, particularly at off-peak times. In addition to reduction of airline costs, the airline benefits because links to the PSDN's and the INTERNET will assist the company. (The airline e-mail system is very good within the airline industry and there are good outward links to FAX's and telex's.)

Our shared data service model is currently undergoing the pains of actual implementation in Kiribati (where we have no airline circuit) and Tuvalu (where we want share to lower our costs). We are grateful for the enthusiasm of the telco's involved and plan to report our results in a year's time.

4.3 VSATs

Despite the popularity of VSATs in other parts of the world we have yet to see commercial services in the Central Pacific. We believe that is due to the relatively low power available on INTELSAT global beams and the lack of a few key customers who could afford to pay the full cost themselves.

After the commissioning of the Pacific

INTELSAT VII (Jan. '94) and alternatives such as PanAmSat, the picture may change due to the higher power levels. We believe however that there will continue to be very strong arguments for shared hubs and shared remote VSATs.

A special class of VSATs, the INMARSAT terminals, will become increasingly important for vehicle location, especially combined with e-mail services. We believe INMARSAT C and its cousin, AERO C, are very appropriate and affordable for low-volume transactional services.[11]

5. Implementation

There is an old saying around the Pacific that the problems are not technical but rather regulatory and bureaucratic compounding the small monetary sums involved. In this age of corporatization and privatization the solutions may be easier. So the question is how do we promote shared data services -- PSDN, and ISDN. We suggest two approaches particularly for the PSDN.

5.1 Privatization of the PSDN

The first is to privatize data services separately from the PSTN, the voice network, provided the data carrier leases the bearer capacity from the national phone company. This would allow the telco to concentrate on POTS and the data carrier to specialize in areas that have relatively smaller cash flows and require different technical knowledge.

This has occurred in the Marshall Islands with respect to travel-related industry data. SITA and Air Marshall Islands lease circuits from the Marshall Islands National Telecommunications Authority, add value and distribute data.[12]

5.2 Telecom cooperatives

The second is through cooperative efforts of data customers, on the model of the airline communication coop, SITA, to meet their specialized needs. Banks which individually lease circuits are good candidates for sharing capacity.

5.3 SITA Initiative

Indeed SITA, as part of its restructuring to meet competition in an increasingly deregulated telecom world, is interesting in providing new services outside of the airline and travel industries. Because of its extensive network we believe it is ideally placed to extend basic INTERNET and PSDN connections world-wide. An example is SITA's new contract to provide X.25 connections to all the Australian embassies. This will introduce X.25 connectivity to several Pacific nations now without such services. (There are also a number of countries, such as Marshall Islands, which nominally have X.25 connections but little to no useful traffic.)

The old coop SITA, as compared with the new commercial subsidiaries, has a recognized Non Governmental Organization (NGO) status that may facilitate projects in some countries.

5.4 Provisioning of ISDN

We look to education and health ministries to take the lead in pushing for ISDN. They have important applications that are cost-justifiable today.

We recently participated in an ISDN basic rate teleconference demonstration with a commercially available system across town in Sydney. The quality of the video was startlingly good and it was easy to switch cameras, bring up computer graphics, etc. I suppose as an airline employee, I should be concerned about such systems displacing air travel. However if I were sick in a small hospital I would want my doctor to have such an easy to use system to consult with doctors anywhere served by ISDN.

Fortunately most island phone companies have the switching infrastructure; the major remaining cost is buying the software. We predict that if ISDN is priced near that of normal voice service there will be considerable demand. Specialized services such as use of the D channel for connection to the PSDN will also be increasingly attractive.

5.5 User's Groups

We believe that users' groups such as the Pacific Rim ISDN/Datacomms Users' Forum can play a useful role. We also want to note the important step taken by the South Pacific Forum Secretariat in inviting users to its trade show and seminar in Suva this past September.

While we believe our island company's data needs are critical, on the scale of Pacific rim data traffic, our requests are insignificant. Therefore it is vital that major business and non-commercial users such as universities coordinate requests to telecom providers. Major systems such as PEACESAT and the University of the South Pacific's are likely to have commercial spinoffs.

5.6 VSAT network

We believe there is sufficient demand for a VSAT data service in the Pacific Islands. The major customers would be airlines, education, air traffic control, banks, weather. The problem is that nobody has done the study. Air Marshall Islands recently asked SITA to design a system for airlines and we hope that by PTC '95 at least a proposal is available. It's the next step to the VSAT papers and products we see and talk about at PTC each year.

6.0 Conclusion

The Pacific Islands have wonderful new POTS in many urban centers. Cost-effective data connectivity are missing links to the global economy. However solutions are waiting to be implemented based on the digital infrastructure already in place and satellite services just becoming available.

Whatever our individual company data needs are, we will be doing a service to our countries by politely but firmly pushing for the services we believe we require.

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EDI Messages and Data Elements for People: Directions for Developments in Hong Kong and Asia

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ABSTRACT

Hong Kong currently has the largest service sector in the world, accounting for 73 per cent of GDP, it's manufacturing sector being now developed in southern China. The role of EDI in the region must therefore mirror this development with emphasis on trade in southern China and services in Hong Kong.

EDI for trade is well accepted throughout the industrialised world. The main issue for southern China is the provision of a suitable infrastructure. Hong Kong is about to embark on a community-wide EDI infrastructure for the trading community in order to encourage all firms, both large and small to be involved in paperless trading. However, Hong Kong should also recognise that the emphasis for EDI in Hong Kong should include the expanding services sector.

1. INTRODUCTION

EDI refers to the transfer of information/data/documents directly from an application running on one computer system to an application running on another computer system across some form of network, without any human intervention. Consequently this data exchange is paperless and it implies the use of structured data and agreed message formats. This structure and formatting have to be agreed generally by standards bodies. The trend is to use the UN/EDIFACT (United Nations/Electronic Data Interchange for Administration, Commerce and Transport) standard. This is an international standard which is being adopted throughout the world, but mainly for Commerce and Transport, that is for trade. As public administrations broaden the use of EDI away from trade it has been necessary to make progress in developing messages and data elements which make the A in EDIFACT more useful to Public Administration. In recent years the range of Message Development Groups in the Western Europe EDIFACT Board has been extended to embrace more non-trade activities. There are now groups concerning statistics, travel, leisure, healthcare and Social Administration. Generally speaking, Messages and Data Elements which describe "people" rather than "traded objects" are being developed. EDI, however, is still in its infancy, particularly in Hong Kong, even for trade, despite the fact that Hong Kong is currently the tenth greatest trading port in the world. The manufacture of the traded goods has now, to a large extent, been transferred to southern China and expanded further. The related import/export, however, is still mainly via Hong Kong. This emphasis on trade has resulted in a very large service sector in Hong Kong - already it accounts for 73 per cent of GDP, the highest percentage of any industrialised country. This compares with 63% in Singapore and 63% in the United States. (Asian Intelligence, 1993). Consequently, for Hong Kong in particular, the potential is enormous given that "... EDI is the way business will be conducted in future" (Shaw, 1990).

With regard to the use of EDI for public administration in Hong Kong, there is currently zero usage outside of trade. This situation contrasts starkly to the situation in Singapore which has nearly 100% processing of trade documents by EDI and has started introducing some non-trade applications such as MediNet. MediNet provides a central claims processing system such that hospitals can send medical claims/insurance claims to government for processing via EDI.

2. EDI PROGRESS IN HONG KONG

It is widely recognised that EDI is one of the directions that Hong Kong should take if it is to remain a competitive trading port. Companies throughout the world are expecting trading partners to "talk EDI". Those that don't may well be left behind. A lot of time, money and effort has gone into the approach required for EDI in Hong

Kong through SPEDI (Shared Project for EDI). The Hong Kong government has now agreed to support those companies that form SPEDI to develope a community-wide

EDI for Hong Kong. Government support is crucial but there are difficulties in setting up such a community-wide EDI in Hong Kong. The Hong Kong business environment is characterised by a very large number of very small business. Greater than 90% of business have less than 10 employees, complicated further by the fact that a number of companies share the same room/space. This is not the same as the situation in Western countries where there is a greater proportion of large/multinational companies. Other difficulties will be overcome in time by which time public sector applications will be progressing. Such difficulties at present are fluidity of Hong Kong companies, complexity of the Chinese written language, volume of trade, access to EDI interface, "critical mass", education and personnel throughput/staff turn over (Walsh, 1991).

Although the idea of a community-wide EDI designed for a national trading community was born in Hong Kong in the mid-1980s if has been successfully employed elsewhere-particularly in Singapore. It is only recently that government backing has been approved in Hong Kong (Kimberley, 1993). The government will take up an equity share of 36 per cent with Tradelink, a private company formed by an equity partnership of 11 major Hong Kong enterprises, taking up the remainder. It seems that Tradelink will get an exclusive EDI gateway to government for seven years which will provide access to trade, customs, and census and statistics department. In return Tradelink will have to provide electronic input and output for up to 120,000 Hong Kong trading companies paying special attention to the needs of the small trader and to Chinese language issues.

3. TECHNOLOGIES, INFRASTRUCTURE AND STANDARDS

The international standard for EDI messaging has now been finalised by the standards bodies CCITT (Consultative Committee of the International Telegraph and Telephone) and ISO (International Standards Organisation) as X.435/F.435. This is an important development and states that the content of the EDI message can be encoded in an appropriate EDI syntax, either EDIFACT, ANSI X12 (American National Standards Institute) or UNTDI (United Nations Trade Data Interchange).

Both E-mail and EDI are now MHS (Message Handling Systems) applications defined by the X.400 series of standards developed by CCITT.

Although EDI as a business practice has already existed for 20 years in a non-standard fashion, it is now seen that X.400 is the natural way to convey such EDI documents. Consequently, with the awareness of the benefits of EDI and its continuous deployment, more MHS systems will be installed as the proper way of doing EDI. It will continue to obtain the desired critical mass by increasing the installed base of X.400 systems. Recently, Hong Kong has seen the inauguration of Hutchison AT & T Network Services (HANS) which gives the previous Hutchison INET X.400 services global coverage through the available AT&T ADMD (Administrative Management Domain) network. Hong Kong Telecom CSL has also launched its X.400 ADMD. An ADMD functions as a central telephone/telex exchange to route EDI messages between countries and does not require an actual link between companies as required when using the private management domain. A similar infrastructure development is now needed in southern China.

In order to get a community-wide EDI in place Tradelink has recently issued an RFP (Request for Proposal) for vendors to provide end-user translation software, central EDI systems for communications and mailbox, and community access services for non-computerised traders. The latter will probably include walk-in and fax-in bureau services with imaging and ICR (Intelligent Character Recognition) provided later.

4. TRADE-ORIENTED EDI

EDI for trade is well accepted throughout the industrialised world. Developing countries need an appropriate infrastructure in place before any meaningful use of EDI can be anticipated.

4.1 TECHNOLOGY TRANSFER

In order to illustrate the needs for EDI in developing countries two important sectors of concern to developing countries will be discussed through examples, the garment industry and cargo. With regard to the garment industry the situation in Hong Kong up to 1989 will be discussed recognising that since that date further development has been transferred across the border to southern China. EDI technology transfer should logically follow this manufacturing technology transfer. The same arguments that applied for the need for EDI in the garment industry in 1989 now apply to the garment industry in southern China.

With regard to cargo, this discussion will relate to the carriage of garments now manufactured in China but exported through Hong Kong. The need for fast delivery and EDI between China and Hong Kong is

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elaborated.

Essentially "just-in-time" manufacture is needed in southern China, which now has a very large manufacturing sector and better transhipment process is required through Hong Kong which now has the biggest container port in the world.

4.2 CLOTHING INDUSTRY IN HONG KONG AS OF DECEMBER 1989

The clothing industry is typically a major sector in many developing countries. This also used to be the case in Hong Kong and consequently the discussion of Hong Kong's situation at that time may now be useful for reference by developing countries.

As of December 1989 there were 10,238 clothing establishments employing 272,979 workers, about one third of the manufacturing workforce. Refer to figure 1 below:

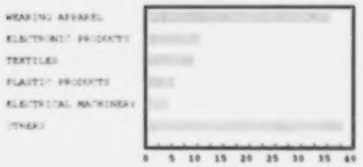

FIGURE 1. SHARE OF EMPLOYMENT IN THE MANUFACTURING SECTOR BY MAJOR INDUSTRIES (DECEMBER 1989)

The industry contributed HK$88.7 billion in 1989, which represents 39.6% of Hong Kong's total domestic exports. Refer to figure 2 below:

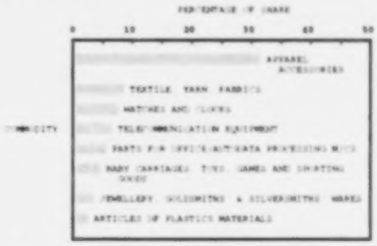

FIGURE 2. *HONG KONG'S DOMESTIC EXPORT BY MAJOR PRODUCTS (1989)*

The initial development of the industry could be attributed to the availability of abundant cheap labour and materials, and the relatively low capital investment. It was establishment in the 1950s, with the assistance of overseas buyers who came to Hong Kong in order to supplement the more expensive domestic products in their countries with cheaper items from Hong Kong factories. Since these beginnings the Hong Kong clothing industry has enjoyed a tremendous period of growth over the past three decades. However, recent efforts of major importing countries, like the USA, to reduce their payments deficit have stemmed this expansion and led to a decrease in quantity but better quality production. The general response of Asian garment suppliers to import restrictions imposed by their major markets has been to bolster production of higher value-added wear. In the case of Hong Kong, manufacture has been transferred across the border where there is a new supply of cheap labour and relatively low capital investment is required.

In the mass-merchandise sector, the market is usually six to twelve months behind the 'up-market', or fashion, sector. In the fashion sector, a period of six to twelve weeks, even six to twelve days, is far more realistic. The so-called sharp end requires "just-in-time" manufacturing. This implies fast communications, manufacturing and transporting. In the fashion industry cost is not always a major concern. Fashion conscious teenage female Americans are well prepared to pay more for a garment that a popular rock star wore on a TV show the previous day if it can be delivered in a few days. In order to cope with this instantaneous flow of information is required between retailers, garment markets, textile manufacturers, freight forwarders, shippers and other involves in the garment industry. That is EDI provides great potential for further development of the clothing industry in Hong Kong and southern China (Straw, 1990).

4.3 EDI IN CARGO HANDLING

Air cargo is also an important business in Hong Kong and very relevant to the fashion industry discussed above. Research has shown that the average air shipment spends no more than 8% of the total transport time in the air. On average, delivery to and from the airport accounts for 20% of this time and the remaining 72% of the total transport time the shipment is kept waiting at the trans-shipment location. Obviously, with these figures in mind perhaps a number of days can be saved in the fashion example above if garments are manufactured where th2e demand is; i.e. within USA. In order for Hong Kong to manufacture fashion garments locally or in southern China and transport quickly to markets in USA then the "just-in-time" principle has to be employed throughout the transport sector. Delivery times are becoming more and more important - even crucial. The bottleneck in the whole transport chain is the transhipment process which is complex and inevitably involves a great number of specialised organisations. Not only hauliers themselves, but also ramp handlers who load and unload cargo units and are responsible for temporary storage of goods, the dispatchers who, on behalf of the hauliers, see to the administrative transfer of the goods, the forwarding agents and the custom brokers who, on behalf of the shipper and the consignee, organise and supervise the transport, and the customs who, on behalf of the authorities, make sure the legal rules referring to export and import are observed. Dependent on the type of transport and/or the type of cargo other specialised companies can be added to the list of those usually involved in trans-shipment.

By having the exchange of information between these company systems conducted through EDI, the trans-shipment process as a whole becomes considerably more efficient. In the application of EDI at the level of external integration achieved by the Dutch air cargo industry through the use of a Value Added Network for EDI, the benefits of this shows the type of service have been proved in practice. It has been found that this, combined with far-reaching automation of import facilities, has made the processing of cargo flows at Schiphol Airport considerably faster, at the same time reducing the cost of the paperwork involved in the dispatch of shipments (Zimmerman, 1991).

5. PEOPLE-ORIENTED EDI

The progress of EDI is rapidly escalating in the industrialised world; mainly with regard to trade. However, this paperless world should not just be restricted to trade. There are many areas in the public sector where we have islands of computerisation, where forms are processed by one computer application and then printed out and sent to another party, only to be re-entered into another computer application, with perhaps some different format. Such offices that are involved in this type of activity are the setting for the use of EDI.
In order to give an idea of possibilities for EDI related to people rather than trade some recent examples outside of Hong Kong are discussed below.

5.1 EDI IN HEALTH ADMINISTRATION

The Workgroup for EDI (WEDI), a forum of healthcare leaders believes that all participants in the health care industry must commit themselves to streamlining administrative processes if EDI is to be successful. Currently the most extensive use of healthcare EDI in USA occurs between providers and payers. WEDI estimates that Medicare contractors receive 80% of Part A claims and 50% of Part B claims electronically (Manus, 1993). They also state that managed care represents opportunities to apply EDI in activities involving eligibility and benefits information, preauthorisation, referrals and utilisation management. Other activity in these areas is in progress by Cooperative Healthcare Networks Statlink, which is a medical claims processing software package (Scott, 1993). In order to facilitate these developments further WEDI recommendations for message content standards under American National Standards Institute ANSI X12 were submitted in July 1992 (Hard, 1992). Also, in October 1992, the Health Care Financing Administration mandated a standard electronic format for remittance advice to health care providers on all Part A Medicare claims, replacing some 400 different formats. (Barlow, 1992)

5.2 EDI IN GOVERNMENT

The Department of Defence (DoD), USA, is still involved in processing vendor invoices through the traditional paper-through-the-mail system. To speed processing, improve communication, and decrease the chance of error, the DoD developed a formal policy for electronic commerce to be implemented worldwide. The US Department of Treasury is also promoting an EDI system among government agencies and their vendors. Payments are made electronically through the security of the Automated Clearing House network for direct deposit into the vendor's bank account. (Woodring, 1993)

Another government activity with EDI possibilities relates to registration. In New Zealand an EDI system has been developed for the operation of the Motor Vehicles Securities Register (Tod, 1992). The purpose of the register is to record, cancel, amend and enquire on all securities over motor vehicles in New Zealand - at least those notified by the secured party to the Registrar.

In addition to paper/fax/courier applications, applications were acceptable via an EDI service. The benefits of the EDI approach mean no physical handling of paper and acknowledgements would be sent back to the secured party electronically, therefore turning around applications in a matter of minutes or hours rather than days. Also, where a "rejection" of an application is made by the Registrar, due to incorrect data, the rejection is returned "electronically" to the person attempting to become the secured party and corrections can be made within the same trading day with accurate and electronically captured audit trails.

As of March, 1991 65% of registrations were made via EDI. This an indication of its success and the Department of Justice is now investigating the conversion of three other major Registries - Births, Deaths and Marriages, Commerce, Lands and Deeds.

5.3 EDI IN EDUCATION

The library and serials publishing communities are actively developing appropriate ANSI X12 message sets so as to transform the way in which libraries, subscription agents and serial publishers transact business. Currently, one of the most widespread implementations of EDI in the serials community in USA has been the exchange of dispatch information between publishers and subscription agents (Santosuosso, 1992).

Another example relates to the UK where there are 109 Local Education Authorities (LEAs) and 30,000 schools (Love, 1992). At the Dept. of Education headquarters in 1990 there were 120 staff involved in processing information from these LEAs - a lot of paperwork. The EDI project was started in April 1990 to handle one task only; that of collecting information on the 1 million teachers for pension purposes. If one task can be handled by EDI then this opens the doors to many other tasks.

A key objective was to get validation at source to improve quality directly. A data modelling exercise established about 400 data entities that were of interest. This data model with descriptions of the required entities/attributes were made available to school software suppliers to encourage them to use them in revising their systems.

It was agreed that a variety of transfer mechanisms would be available to schools. The preference was for electronic transfer via a Value Added Network. However, diskettes were acceptable as part of an migration path to full network connection.

This project was judged a success in that over the two year period costs were reduced by 23% along with the benefits of accuracy, timeliness and less paper.

6. REGIONAL DEVELOPMENTS

Countries in the Asian region are at various stages with their development of EDI. There is little activity, as yet, in China and The Philippines, whereas Singapore has almost 100% trade by EDI, and has progressed well with "people-oriented" EDI. Other countries, such as Malaysia, Thailand, Taiwan and Korea are putting trade EDI in place.

China's agency for promoting EDI application, CEC, was established in September 1991. In order to popularise the concept CEC has run a number of seminars on Chinese EDI and has been involved in translation of the EDI standards into Chinese. A few pilot projects have also taken place, with most activity in the vicinity of Hong Kong where the infrastructure is better developed. Telecommunications traffic between Hong Kong and China is expanding rapidly and increased by 35% in 1991 over previous years.

The Philippines main concern is the development of the telephone infrastructure. Currently, the telephone density is 1.3 per 100 persons which is the second lowest telephone density in asia. Indonesia has only 0.77 telephones per 100 people.

Malaysia has set 1995 for a national EDI network. An EDI committee has recently been established to become the umbrella body for EDI implementation in the country. There a currently a few VAN operators providing EDI services, one of which, EDI Malaysia, is strongly tipped to become the national EDI operator.

Thailand is to set up an EDI trade facilitation point in Bangkok, known as Trade Point. This facility will group all service providers involved in foreign trade transactions. Trade Point is a United Nations programme which already has 22 pilot sites in 19 countries.

Taiwan has embarked on a six-year plan to simplify and automate many governmental and business functions in order to implement an EDI VAN. The short term objective is to make the cargo clearance automation become a reality. The mid-term objective is to build up the automatic processing environment across the various parties to the cargo community. The long term objective is to reach the stage of paperless international trade.

Korea has been involved with pilot projects, where 29 messages are used, in its development of paperless trading by KTNet and aims at 1994 for an initial provision of a fully-fledged commercial service for every trading circle. Currently 9 message development groups are active and the end cost of the whole systems is estimated to be US$130m.

Singapore is the most advanced country in the region in its use of EDI and expects EDI to become the basic infrastructure is every business sector. TradeNet is well established and is now linked to various communities such as air, port, cargo and shipping including US customs to facilitate clearance of shipments. In additions, a large number of other services have been implemented, some of which are more "people-oriented": MediNet, BizNet, OrderLink, MailLink, LawNet, StarNet, GlobalNet, GraphNet, ProfNet, RealNet, DunsLink, $Link, AutoNet, EPCNet and GlobalLink. As extra services to various communities, databases have been added for information retrieval. For example Databases on cancer, drugs and

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poisons to MediNet and databases on products and services to ProfNet.

7. IMPLICATIONS OF EDI FOR DEVELOPING COUNTRIES

The above description of EDI developments in the Asia region illustrates the issues that developing countries have to consider. These issues are merely listed again and expanded below:

- *popularise the concept*
  As with any communications technology (telephone, fax etc.) a critical mass of users is required - this takes time and a lot of education through seminars, conferences, etc.

- *EDI Committee*
  An umbrella body should be established in order to provide a focus for the community, give direction and set objectives.

- *simplify procedures and business functions*
  For example, according to a recent survey by the Korean Customs Administration, to finish one trade transaction:

  "- a maximum of 27 government agencies and organisations are involved
  - a maximum of 40 different papers are required
  - an average of 200 data elements are to be inputted
  - 60-70% of data are to be rekeyed in the processing
  - an average of 30 data elements are to be repeated (Kim, 1992)"

- *developments elsewhere*
  Learn from more advanced and well established EDI communities as well as other existing standards/facilities; e.g. UN/EDIFACT, United Nations Tradepoint programme etc.

- *infrastructure*
  Obviously EDI involves networks of some sort - this is often the most difficult consideration.

- *cost*
  This is another difficult consideration, even when telecommunications infrastructure is in place. For example, Korea estimated US$130m for its EDI provision and Hong Kong estimates US$100m. In both cases there are concerns about payback.

- *trade first*
  In order to ensure a faster payback consider setting up trade networks first and people-oriented networks later.

- *pilot projects*
  In order to get the "feel" for EDI and as a mechanism to get some of the various communities "actively" involved, pilot projects are essential.

- *message developments*
  EDI involves the transfer to standardised messages some of which will need to be designed locally whilst adopting as many as possible.

8. CONCLUSION

It can be ascertained from the above that EDI developes in stages from the development of appropriate infrastructure through to EDI being used throughout all sectors. This paper has described applications in many environments in order to highlight possibilities. It should be noted that these applications themselves use a variety of standards, typically ANSI X12 or even proprietary closed systems. Given the trend to move to one universal standard for EDI, that of UN/EDIFACT, this development requires the design and use of approved standard messages. With regard to Hong Kong some such messages have been either developed in Hong Kong or United Nations standards Messages (UNSMs) have been approved for use in Hong Kong. Also sub-sets of UNSMs have been agreed as suitable for use in Hong Kong (STEDI, 1992).

The issues that need to be considered by developing countries have been highlighted, however, these are more concerned with getting started with EDI. The main issue is that EDI is here to stay and will be developed tremendously in many sectors in the near future.

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Role of Multimedia Communication in the Teleworking and Telelearning Field

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1. ABSTRACT

We studied communication between distributed offices in a telework environment. We analyzed the characteristics and roles of communication media, focusing on distributed software development and distance learning for engineers. We then examined the relationship between the characteristics of communication media and the communication method in teleworking, and the optimum uses of multimedia systems.

2. INTRODUCTION

Multimedia communication systems are expensive, both to install and to operate, because of the high line cost. We have devised ways for potential users to evaluate the cost-effectiveness of various telework options. Our evaluation includes implementation criteria for particular communication systems. Currently available hardware can transmit voice, images, video, and data at high speed. Systems are characterized by their software, which determines the forms of information the system handles, and the services it provides.

3. TELEWOKING AND COMMUNICATION SYSTEMS

Our division, Fujitsu Communication Software Division uses a network to link local offices. The network allows us to locate offices outside big cities, providing a better working environment. It improves channels for exchanging ideas, and widens our recruitment scope. The two main network applications are communication between distributed offices, and training engineers working at distributed offices.

Table 1 COMMUNICATION SYSTEMS

Communication system	Network	Voice	Text	Image	Video	Shared window
Telephone	Telephone	✓				
E-mail			✓			
Facsimile				✓		
Audio conferencing	Telephone	✓				
Telewriting board		✓		✓		
Satellite video network	Satellite link	✓			✓	
Video conferencing	ISDN, LAN/WAN	✓		✓	✓	
Desktop conferencing		✓	✓	✓	✓	✓
Multimedia e-mail*		✓	✓	✓	✓	

* Experimental

We opened our first distributed office in 1979, and have gradually opened more since then. At first, the principal communication means were telephone and fax(Table 1). We later installed electronic mail, telewriting, in the form of a shared electronic whiteboard, and other facilities. The next stage was providing video and desktop conferencing systems.

Telewriting copies pen strokes made on a whiteboard at a remote location onto a local whiteboard (Figure 1). Video conferencing has, however, almost completely replaced telewriting. The video conferencing system (Figure 2) displays images from a remote site, such as the faces of conference attendees and conference materials, on a local monitor. It is also possible to write over displayed images, in the same way as writing on a whiteboard.
The desktop conferencing system, which is implemented by adding a video board and software to desktop workstations, provides moving pictures, shared whiteboards, and shared windows (Figure 3). Unlike video conferencing, which requires a special meeting room, desktop conferencing is versatile since it can be combined with applications on workstations.

Satellite video networks are used for remote education. A lecture can be heard in real time at remote sites by means of satellite links. Question and answers are done by telephone. Remote Computer Assisted Learning (CAL) is also used to improve engineers' skills (Figure 4).

Electronic mail (e-mail) is widely used to exchange text, documents containing graphs and images, spreadsheet data, and data for other software. The communication of voice and video through electronic mail, however, is still experimental (Figure 5). We are implementing a multimedia e-mail system based on a continuous media (CM) player developed by the University of California. The CM player can play scripts composed of one or more synchronized data streams, e.g., digitized video or audio, animation sequences, image sequences, and text.

The video stream from a VCR is compressed by an encode/decode(codec) chip on a video board and stored as a sequence of pictures in a file server. Playback software on a client workstation reads the CM data from the file server and allows the user to play the video forwards or backwards at several speeds and to synchronize the video signal with audio (Figure 6).
This system enables various teleworking and telelearning applications.

4. EFFECTS OF MULTIMEDIA ON VIDEO CONFERENCING

Two years ago, we installed a video conferencing system at Base offices in Japan and the US for conferences between distributed offices and group discussions (Table 2). We plan to expand the system to all our distributed offices. Remote conferences occur two or three times a day, on average, with a typical conference duration of about 1.5 hours. Most conferences use the moving picture feature to display remote attendees. The picture quality is, however, unsatisfactory because of the low transmission speed. Facial expressions can sometimes be seen, but subtle changes in the eye contact and movement of the mouth cannot. The optional camera for showing documents, packages, and other objects is only used for short periods. Documents and other materials are generally sent by e-mail or fax before the conference.

Table 2 Current Video Communication System Specification

Item	Video conferencing	Desktop conferencing
Encode/decode	H.261	JPEG
Line interface	ISDN 2B	TCP/IP
Line speed	128 kbps (domestic) 112 kbps (for US.)	64 kbps

(1) Comparison with audio conferencing
We asked users to answer a questionnaire about how the video conferencing system compares with audio conferencing systems(Table 3).

Table 3 FEATURES OF THE VIDEO CONFERENCING SYSTEM

Feature	Importance (%)
Speaker can see how the listeners react	54%
Attendees do not tired because voices are clear	40%
To identify the attendees	39%
All attendees can concentrate on the conference	32%
To see attendees who are not speaking	25%
To see the expressions and gestures of the speaker	24%
To identify the speaker	23%
Conference proceeds smoothly	21%
Atmosphere encourages the speakers to be candid	12%

(2) Use of the screen
We recorded images received during conferences and studied when attendees look at the screen(Table 4).

Table 4 USE OF THE SCREEN

All attendees look at the screen
- Before the conference begins or when joining a conference which has already begun.
- When a person is introduced.

Attendees glance at the screen
- When asking a remote attendee a question.
- * When another person at the same site is speaking.
- * When a person at the remote site is speaking.
- Just before speaking.
- * While speaking (except during questions and answers).
- When a question is not answered.
- During a long silence.
- When being questioned by a person at the remote site.

* If someone talks for longer, attendees look at the screen more often.

Attendees look at the screen for extremely short periods of time during conferences. They spend most of their time studying materials and documents and taking notes. Attendees look at the screen to identify people at the remote site, to see how listeners are reacting, and to look at the speaker. Individuals differ in how often they look at the screen and whether they like or dislike looking at the screen.

5. ROLES OF MULTIMEDIA COMMUNICATION

We also considered the role of media in remote personal communication.

(1) Communication models
The study of behavioral science has produced many communication models that clarify what type of communication is needed and appropriate work methods.[6-8] According to Schramm's model, communication is not unidirectional from the sender to the receiver, but circulates.[9] Schramm's model does not, therefore, distinguish between the sender and receiver. If we consider communication as message circulation, an image of the receiver feeds back their reaction to a message, or acts as a cue to speak, which helps the conference proceed. Image media transmit expressions, movements, and other signals, not necessarily with speech. In some cases, the image itself is a nonverbal message from the sender.

(2) Verbal and nonverbal communication
As has often been pointed out, nonverbal communication is at least as important as verbal communication.[10] Video conferencing systems

convey nonverbal messages by tone of voice and posture. Unfortunately, since the system's moving picture quality is poor, it does not convey subtle nonverbal messages such as facial expressions and eye contact. Presently available systems supplement or reinforce verbal messages.

(3) Purpose levels

We can classify the purpose of communication as shown in Table 5. Many conferences have a purpose level of 1 or 2. They are often used to communicate notices or reports, to share information, or to introduce people. Even conferences where a topic is examined are often at purpose level 3 because the materials being discussed have been exchanged in advance for 90% of such conferences. The purpose level that can be achieved through video conferences is relatively low.

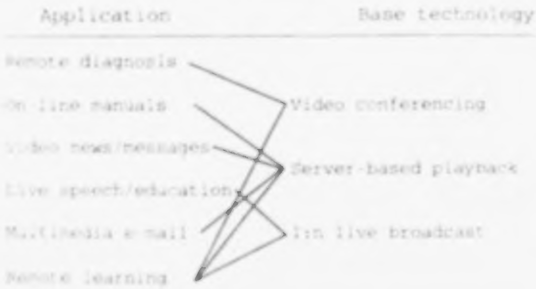
Table 5 LEVELS OF COMMUNICATION PURPOSE

Level	Description
High	
↑ 5 Persuasion (negotiation)	Action on person
4 Creation	Creation from scratch
3 Decision	Selecting one opinion from a number of different ones
2 Coordination	Sharing of recognition standard
↓ 1 Transmission	Sharing of information and knowledge (transmission of information from an informed person to an uninformed person)
Low	

6. MULTIMEDIA APPLICATIONS FOR TELEWORKING AND TELELEARNING

We propose the effective applications for multimedia communication systems in the teleworking and telelearning fields as shown in Table 6.

Table 6 MULTIMEDIA APPLICATIONS



We believe that non-real time communication methods, such as multimedia e-mail or remote learning systems should be emphasized. It can be difficult to arrange convenient meetings between offices in different time zones. For example, meetings between Japan and the east coast of the US must be held in the early morning or at night because of the 14-hour time difference. A possible solution is to exchange prepared information in advance through electronic mail and to only use the video conferencing system for answering questions and for discussions.

We also suggest remote learning based on a network environment. The proposed system, which integrates a desktop conferencing system, a VCR in a workstation, and a remote CAL system, allows engineers to train via a workstation on their desk (Figure 7).

7. SUMMARY

Our experience with remote conferencing suggests that moving picture media, even with a low picture quality, can be useful for communication with limited aims. People that know each other well can use the video conferencing as if they were talking to each other in person, because their communication is based on common recognition, background, and experience.
We will continue to test multimedia communication systems and study their applications to teleworking and telelearning. We aim to find the correspondence between the purpose of communication and the most suitable media.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to Prof. Lawrence A. Rowe of University of California, Yasufumi Toyoshima and Charles Brauer of Fujitsu Network Transmission Systems, Inc. for continuous cooperation and encouragement.

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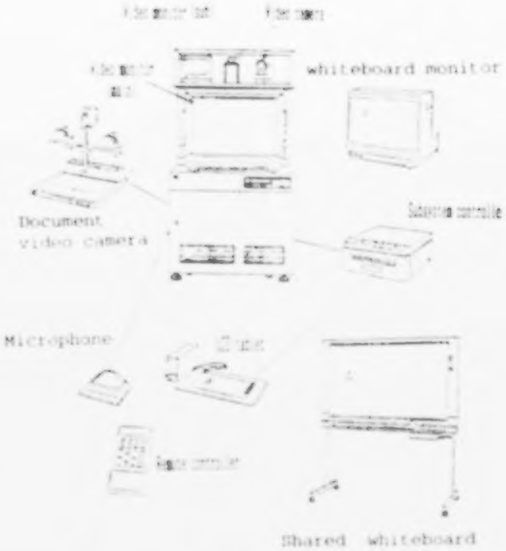
Video monitor
Video camera
Video monitor
whiteboard monitor
Document video camera
Subsystem controller
Microphone
LCD tablet
Remote controller
Shared whiteboard

Figure 2 VIDEO CONFERENCING SYSTEM

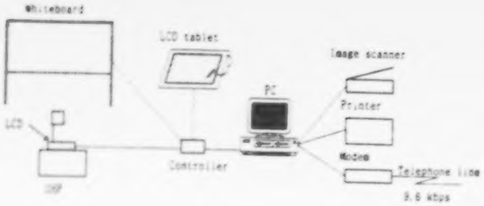
Whiteboard
LCD tablet
Image scanner
PC
Printer
LCD
OHP
Controller
Modem
Telephone line
9.6 kbps

Figure 1 TELEWRITING SYSTEM WITH SHARED WHITEBOARD

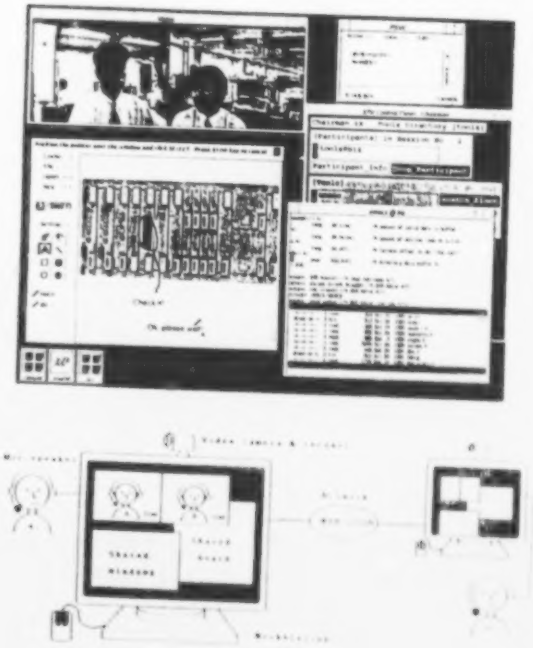
Video camera & speaker
Shared windows
Shared board

Figure 3 DESKTOP CONFERENCING SYSTEM

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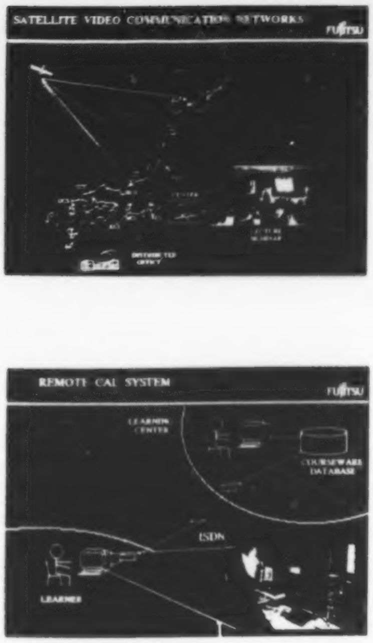

SATELLITE VIDEO COMMUNICATION NETWORKS
FUJITSU
REMOTE CAL SYSTEM
FUJITSU
LEARNING CENTER
COURSEWARE DATABASE
ISDN
LEARNER

Figure 4 SATELLITE VIDEO NETWORKS AND REMOTE CAL USING ISDN

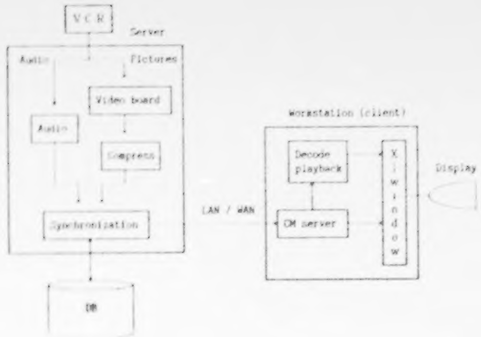
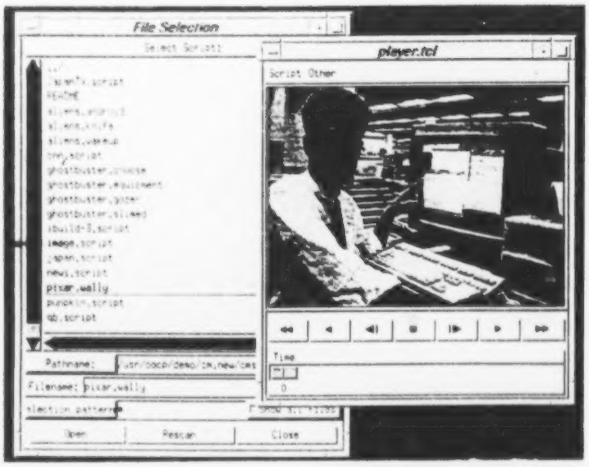

VCR
Server
Audio
Pictures
Video board
Audio
Compress
Synchronization
DB
LAN / WAN
Workstation (client)
Decode
playback
CM server
X window
Display

Figure 6 VCR IN WORKSTATION


File Selection
Select Script:
../
Japan's.script
README
aliens.android
aliens.knife
aliens.wakeup
cnn.script
ghostbuster.choose
ghostbuster.equipment
ghostbuster.goter
ghostbuster.slimed
ibuild-3.script
image.script
japan.script
news.script
pixar.wally
punkin.script
qb.script
Pathname: /usr/tocp/demo/cm,new/cms
Filename: pixar.wally
Selection pattern:
Open
Rescan
Close
player.tcl
Script Other
Time
0

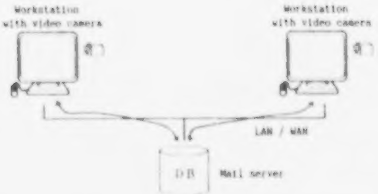

Workstation
with video camera
Workstation
with video camera
LAN / WAN
DB
Mail server

Figure 5 MULTIMEDIA e-MAIL

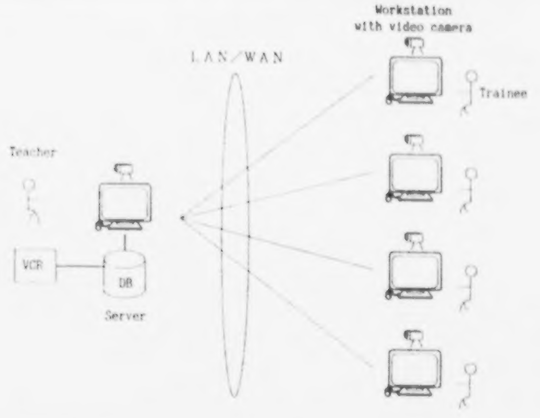

Workstation
with video camera
LAN/WAN
Trainee
Teacher
VCR
DB
Server

Figure 7 REMOTE TRAINING AND EDUCATION BY CM PLAYER AND DESKTOP CONFERENCING

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Telecommunications and Transportation in a Developing Economy

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Abstract

Telecommunications usage acting as a *substitute* for transportation is intuitively obvious and intellectually satisfying. This substitution has been empirically demonstrated in the case of telecommuting. However, commuting reduction and other travel substitution applications of telecommunications are only half the story. Many distinct economic and social mechanisms listed in this paper lead to an opposite effect: telecommunications as a *stimulant* of transportation demand. This paper suggests that the overall combined effect of travel substitution and stimulation from the expanding use of telecommunications may be causing net growth in vehicle traffic.

Introduction

Conventional wisdom about social and economic behavior holds that the use of telecommunications is a natural substitute for transportation. For example, telephone calls can replace travel to meetings, and facsimile transmission of documents substitutes for courier or postal delivery. Information can be moved instead of people and goods. This view of telecommunications as a travel substitute is expressed matter-of-factly in paragraph 7 of the summary of the *Report of the Independent (Maitland) Commission for World-Wide Telecommunications Development*. "Telecommunications play an essential role in reducing the need to travel."

This paper provides additional, cautionary perspectives on the idea that telecommunications plays an essential role in reducing the need to travel. We explore how applications of telecommunications can act as a trip substitute, and simultaneously as a travel stimulant.

In the United States, the travel substitution characteristics of telecommunications have been acclaimed by some policy mavens, who declare that telecommunications can be thought of as "information transportation." Instead of moving people and paper in vehicles riding on heavy, costly infrastructure, the information in people's heads, desks, briefcases, and computer files is transmitted at the speed of light through cables and the air.

Telecommunications as a transportation substitute is thoroughly embedded in the thinking of most transportation researchers and government planners. Many erroneously use the words "telecommunications" and "telecommuting" interchangeably. Specialists restrict the word "telecommuting" to mean those employees and employee-like contract workers who do not commute between home and an office on some of their work days. But the term has been expanded by journalists and politicians to reference any work-related practice involving telecommunications that seemingly cuts down on travel, such as operating a home-based business, receiving classroom instruction by video conferencing, or sending medical x-rays to a clinic across town by wire rather than by envelope and messenger.

Review and Assessment of Research

Quantitative studies of the relationship between telecommunications and transportation are of two types:

- Empirical studies of the travel behavior of small groups of telecommunications users.
- Analysis of historical statistical series covering some aspect of the travel behavior of national populations.

The small group research includes a series of recent studies of North American telecommuters in California, Washington State, Arizona, Texas, British Columbia, and around Washington, DC. These studies have determined that office workers telecommuting from home or a special neighborhood center one or two days per week do indeed cut down on their commuting mileage (1). A few other small group studies have examined the travel effects of video teleconferencing. These have generally shown that travel reductions do *not* occur. In one case, travel increased when a remote videoconferencing site attracted extra meeting attendees who were curious to see how teleconferencing worked (2).

Studies of the second type, which analyze statistics for an entire country or region, offer mixed results: that videoconferencing usage in Europe did not grow as a result of the Persian Gulf War even though business travel dropped (3), that information workers in the United States have shorter commutes between work and home (4), and that telephone usage in Costa Rica is correlated positively with transportation accessibility (5).

In an extensive body of published work that extends back to the early 1980s, Ilan Salomon has consistently argued against the conventional wisdom that telecommunications is a substitute for transportation. He notes in one study (6), "There is, at present, very little evidence to support the substitution [of telecommunications for transportation] hypothesis." He writes in another paper (7), "The findings [from an empirical study of telecommunications' impact on regional inequalities] suggest that reduced telecommunications costs do not have a major impact on changing the relative weights of location factors. The interplay of demand, supply and government intervention indicates that the disadvantage of distance will persist in the information era." The basic thrust of his work is that there is much more to be learned about how travel and telecommunications interact.

The United States Congress in 1991-92 ordered the U.S. Department of Transportation and the U.S. Department of Energy to study the travel implications of telecommuting. The Transportation Department responded to this mandate by extrapolating estimated travel substitution rates determined in small-scale demonstrations of telecommuting into projections of U.S. nationwide travel savings (8). USDOT estimated that savings over ten years would reduce total vehicle miles traveled by approximately one percent below what travel would be without telecommuting.

In response to the same legislative mandate, the Energy Department went beyond examining reductions in the daily journey to work. Researchers analyzed a wider variety of structural relationships between telecommunications and travel, some of which are discussed in this paper.

Travel Substitution Effects

Emerging from the Department of Energy analysis is a comprehensive list of the trip replacement effects of telecommunications.

- Telecommunications allows sporting, entertainment, political, religious, and other events to be broadcast to a dispersed audience, rather than have the audience travel to the event. In the U.S., revenue from electronic distribution of movies via cable TV now yields much more revenue than theater tickets.

- Telecommunications allows information to be sent in electronic form rather than in the form of physical documents. Electronic mail, electronic data interchange, computer file transfer, and fax are common manifestations of this.

- Telecommunications enables humans to communicate in electronic meetings across any distance rather than traveling to common meeting locations. This includes remote medical consultation and distance education, as well as multi-party teleconferencing and even plain old telephone calls.

- Telecommunications enables observations from dispersed sites to be collected via remote sensing and transmitted to a central point, rather than sending a human observer. The use of telecommunications by Entergy, a New Orleans based electric and gas utility, is an example of such observations that can affect large populations. This company is deploying telecommunications-based services to customers in the Chenal Valley, Arkansas area for remote meter reading and for energy demand and supply management.

- Teleconferencing, computer networks, electronic document flows, and remote sensing let organizational managers disperse and otherwise rearrange work site locations. Managers sometimes use these technologies to set up configurations that reduce transportation of employees, customers, raw material input, or production output.

- Telecommunications enables people to initiate immediate travel to a needed destination only upon the condition of being summoned. This communication replaces traveling to a location unconditionally in anticipation of a need that has only a possibility of arising. Modern telecommunications enables the potential traveler to lay the foundation for more productive travel through remote pre-negotiation, fact finding, or trouble shooting.

- Telecommunications allows consumers to make purchases without traveling to store locations. This permits the movement of goods to bypass the transportation-intensive process of wholesale and retail distribution.

- Telecommunications allows service transactions and events to be carried out in ways that require no travel, or less travel. Such transactions include payroll direct deposits instead of taking paychecks to the bank, electronic income tax filings rather than mailing tax returns, and going to neighborhood electronic kiosks rather than traveling downtown.

- Telecommunications leads to some household activity patterns that consume lower levels of transportation than the alternatives. In other words, interactive television in homes may mean fewer shopping trips, if people would rather spend time interacting with the TV than shopping at stores. This kind of travel substitution does not require that people use the interactive TV for fulfilling a purpose for which they normally would travel: they could be using telecommunications for a purpose unrelated to their travel alternatives. Still, one particular primitive form of interactive TV in the U.S., phoning to purchase merchandise displayed on the two nationwide home-shopping cable TV channels, is showing 20 percent annual revenue growth (9).

From Substitution to Stimulation

An important observation about the above list is that telecommunications substitution for transportation that works really well typically evolves into a growth in telecommunications volume that explodes beyond what transportation is capable of providing. Faxing may begin as a substitute for use of couriers, postal mail, and overnight express, but then fax volumes build beyond what these physical delivery mechanisms could ever handle. As fax diffuses and becomes universal, substitution of fax for document transport is no longer an operative concept. Fax communications by then has a momentum of its own. Similarly, the vast majority of voice telephone calls can no longer be construed as a substitute for travel, nor can ten million people watching a soccer game on television translate into a reduction of ten million person-trips to the stadium.

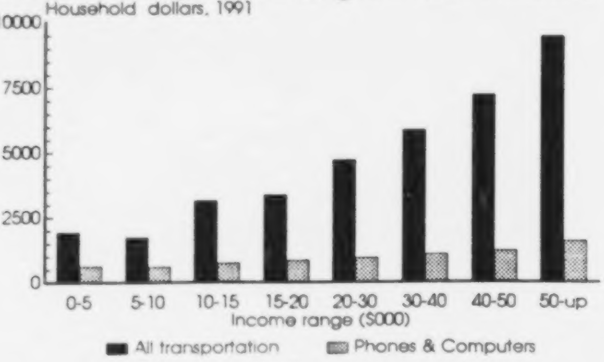
Furthermore, as telecommunications volumes build independently of direct substitution for transportation, there begins to be an opposite effect, namely, travel stimulation. The expanding millions watching soccer on TV provide a growing pool of people who begin to consider going to the stadium occasionally. Intensive telephone, video, and fax interchanges between people who barely know each other creates desire for follow-up face-to-face meetings. A number of distinct stimulation effects can be identified, as seen in the next section.

Travel Stimulation Effects

Our research for the U.S. government has brought out the following list of travel stimulation mechanisms of telecommunications:

- Telecommunications makes people aware of additional general audience events and opportunities that are reached through travel, such as political rallies, professional conferences, entertainment events, and shopping opportunities.
- Telecommunications causes economic growth, productivity improvement, and income growth at the individual, organizational, and societal level. Extensive databases and powerful computer-based econometric techniques have recently allowed this causation to begin to be empirically demonstrated (10). More money means more travel. As illustrated in Figure One, economic statistics in the United States show a much higher income elasticity of demand for consumption of transportation than for computers and telephones.
- The construction of new telecommunications infrastructure arising from user demand leads to travel at all stages of the developmental process, especially where skills, equipment, and materials need to be imported. With the fall of the Berlin Wall, one of the first major initiatives by the science community within the Russian Federation has been to improve the telecommunications infrastructure that connects the former Soviet Republics to the already well-connected science community in the West. This initiative has already spurred travel to plan and create this infrastructure.
- As the economy grows, telecommunications expands the number and geographic scope of economic and social relationships in which people and organizations engage. Electronic mail and toll-free telephone numbers are examples of relationship-expanding communications technologies that allow more rapid and more far-reaching transactions and interactions. These relationships sometimes generate travel, in addition to telecommunications volume. Such relationships include selling, buying, servicing, employment, memberships, friendships, and family. Even if the ratio of communications to transportation is very high in the transactions generated by new relations

Figure One: U.S. transportation and telecom consumer expenditures grow with income.



Data source: U.S. Bureau of Labor Statistics first formed over telecommunications networks, there is still some amount of new trip-making that pushes up transportation volumes.

- Telecommunications permits geographic decentralization of residential settlement, and of organizational activity locations. Decentralization leads to higher travel consumption, because trip origins and destinations tend to be farther apart. For example, Americans who live in the suburbs of metropolitan areas travel an average of 17,700 annual vehicle miles per household. People who live in the higher density central cities travel on average 11,400 miles per household, according to the Nationwide Personal Transportation Survey.

- New telecommunications functionality resulting from digital switching and fiber optics supports the urbanization of rural communities together with associated growth in economic activity. This pattern typically causes more local automobile traffic and a flow of visitors using transportation from distant locations. Increasing traffic congestion is visible in Sequim, Washington; Sun Valley, Idaho; and Bend, Oregon, symbols of rural renaissance in the Northwest United States.

- Telecommunications speeds up the pace of economic activity, as futurist Alvin Toffler writes in *Powershift* (11). He describes how wealthier nations simply operate at higher speeds than less developed countries. The same idea is expressed by business consultants in the phrase, "time-based competition." The acceleration of commerce tends to generate customized, single-purpose trips that leave immediately and go by the fastest means. The quickest modes of door-to-door surface transportation in most metropolitan areas are single occupancy vehicles and small trucks. These modes generate more traffic congestion than moving the same volumes in mass transit vehicles and large trucks.

- Telecommunications enables rapid response systems that dispatch customized vehicle trips to meet personal and organizational needs. Several examples of this are just-in-time logistics, home delivery of fast food, overnight package delivery, and temporary employment services.

- Telecommunications enables a wide variety of new last minute information flows that generate personal travel through attractive invitations and compulsory orders to attend.

- Telecommunications makes travel time more productive and more feasible for travelers; use of wireless mobile phones while traveling is the leading example. In the U.S., wireless data communications between office computer networks and portable personal computers is a new capability being deployed to improve the productivity of business travelers.

- Telecommunications makes the transportation system work more effectively and efficiently. Examples of this are air traffic control, computerized airline reservation systems, and Intelligent Vehicle Highway Systems (IVHS, also called smart highways).

- Spectacular growth in the use of the worldwide Internet computer network has spurred more international collaboration among scientific researchers in developing countries. Electronic interactions between these scientists spurs travel to science facilities, such as the Center for Nuclear Research in Europe (CERN), or to professional meetings, such as the first 'Computational Sciences' conference held in Malaysia in 1992 (12).

Telecommunications-Transportation Interaction Model

Based on the two lists just presented, what we are seeing in telecommunications, therefore, are trip substitution opportunities simultaneously arising with travel demand growth.

Figure Two is a graphic that illustrates our model of the interaction effects between transportation and telecommunications in any country. The graphic is a mathematical construction of plausible economic effects unrelated to any specific empirical data. It is intended to illustrate generic structural relationships. This graphic is derived from a similar one shown by Salomon (13).

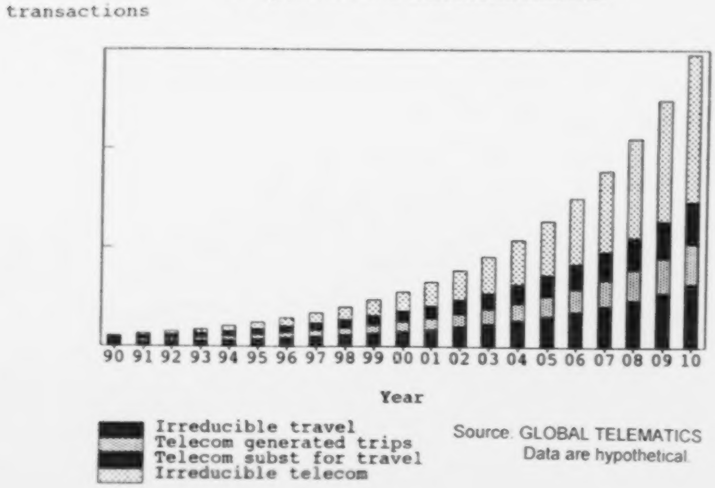
The assumption made here is that transactions are a common metric for measuring both telecommunications and transportation. The Figure shows overall transaction volumes mapped as annual quantities in the vertical bars. The bars are divided into four sections, the lower two of which are travel transactions. The upper two sections in each bar are telecommunications transactions.

The telecommunications transactions are made up of those that are a substitution for travel, and telecommunications that bear no relationship to travel. Similarly, the transportation transactions are made up of those that are stimulated by telecommunications for one of the reasons on the list previously presented, and those that are not.

This model highlights two key points about transportation-telecommunications interactions: first that telecommunications is both a substitute for travel and a stimulant. And second, that the net overall effect of telecommunications on transport, whether a net substitute or net stimulant, depends on whether list one or list two given above is dominant. If telecommunications substitution events add up to more travel miles saved than those miles generated by telecommunications-induced stimulation, then there is net substitution. If the reverse is true, then there is net stimulation of travel by telecommunications.

In Figure Two the trip-replacing telecommunications transactions are set equal to trip transactions that are

Figure Two: Simulation of interaction between transportation and telecommunications.



Source: GLOBAL TELEMATICS
Data are hypothetical.

stimulated by telecommunications. Thus, the effect of telecommunications on transportation volumes is shown as neutral. However, this neutrality is an arbitrary assumption made in the absence of data that measure both kinds of transactions in an entire economic region.

Whether the effects in the earlier list of travel substitutions outweigh the effects in this last list of travel stimulants is still an open question. Nevertheless, we believe that these effects can be influenced in developing countries through public policies that recognize and respond to the complexities.

Certainly travel demand is showing very strong growth in advanced and developing economies. As we have shown above, this growth occurs even as telecommunications volumes grow. Growth in travel is of course influenced by current policies and prices affecting transportation. When travel on the usual routes becomes impossible, such as the occasion of bridges and roads made impassable around San Francisco following the October, 1989 earthquake, telecommunications usage and telecommuting soars, until the roads are restored. But, some new telecommuters continue the practice part time when conditions return to normal (14).

An analytical econometric determination of how telecommunications and transportation have been balancing out as economic inputs in normal (non-earthquake) economic circumstances to date is an important research need. The scale of analysis could range from metropolitan region to nationwide to cross-national comparisons. Telecommunications functionality has been getting better and traffic congestion getting worse for a quarter century now. We should therefore expect to see by now a trend toward travel substitution emerge in economic input-output tables, if the conventional wisdom on telecommunications holds true as commercial and social interactions evolve. Careful measurement is needed.

Effect of Improvements in Telecommunications

Will wider deployment of telecommunications, or qualitative improvements in telecommunications reduce the need for travel? Some public policy analysts have argued that government regulatory changes to accelerate the deployment of switched broadband telecommunications to residential premises, small businesses, and community service facilities such as school and libraries would boost the use of telecommuting and other travel-substituting applications of telecommunications (15).

The argument for explicitly modifying public policy to push deployment of broadband for travel substitution derives from the idea that higher bandwidth and associated higher cost-effectiveness of applications would accelerate trip substitution. For example, do currently available telecommunications functions that are usable on existing high speed communications networks make remote access as good as "being there," thus making travel less necessary? Experiments with these communications technologies and functions to date do not provide any hint of this result; in fact the opposite is shown. For example, a detailed evaluation of a long-term, complex, continuous video connection between two Xerox Corporation laboratories, called a media space, concluded: "Mediated communication systems such as the media space are frequently compared to face-to-face interaction. It is important to reiterate that we did not try to replace face-to face communication nor do we believe that mediated communication can replicate the face-to-face experience." (16)

Could broadband offer new, unforeseen services that in some manner provide people with a compelling reason to travel less frequently? The evidence to date on the compelling things that people do now, such as eating, sleeping, having various kinds of fun, engaging in addictive behaviors, and so on, is that people invariably like to do them in a variety of different locations. Tens of thousands of drunk driving deaths every year illustrate that people like to move around even when they most definitely should not.

The deployment of interactive, more functional, higher bandwidth communications into homes will surely allow more practice of telecommuting, if that is what company managers and their employees continue to find works best. Growing telecommuting is the trend in the United States (17). But at the same time a better telecommunications infrastructure available sooner will not automatically alter the dynamics that make telecommunications a travel stimulator, as described earlier: due to new relationships and transactions over a wider area, economic growth, suburbanization, transportation improvement and just-in-time logistics. Simply accelerating the deployment of high speed and more functional, interactive telecommunications services into more end user locations is unlikely to transform the economy toward lower transportation intensity. More powerful telecommunications will feed all of the ways in which telecommunications expands the motivations to travel.

Whether the widespread deployment of more powerful, higher bandwidth telecommunications will lead advanced economies to show higher telecommunications intensity and lower transportation intensity also depends on changes in the price-performance of transportation. In the United States, for example, except for the cost of delays, the cost of driving automobiles, based on fuel prices, vehicle prices, and taxation, is declining (18).

Recommendations for Government Policy

The U.S. experience of the last few decades does not reveal a natural process of telecommunications substituting for travel. Both grow together, one feeding the other. Travel per household is rising, urban congestion is increasing, and latent demand for travel emerges clearly when new road capacity is opened up.

To change to a different developmental path from that followed by the United States, governments could take steps to coordinate telecommunications policy and transportation policy in light of the interactions described here. The overall challenge is to allocate resources and attention reasonably across the entire spectrum of networks -- from vehicular to optical-electronic -- that provide support for the transactions and relationships comprising economic and social life.

We have several recommendations for governments in developing countries that would help them to reach a mix of transportation and telecommunications utilization that supports appropriate economic growth and environmental protection. We offer these under the assumption that transportation is generally more well understood and politically supported than telecommunications.

- Emphasize education and training in the newer telecommunications-related skills -- such as effective use of telephones and computers -- that increasingly contribute to economic functioning.
- Design and implement government demonstrations of telecommunications-intensive service delivery processes that reduce the need for citizens to make special trips to government offices. Telephone access to services, and electronic kiosks in public gathering places are examples.
- Manage transportation with policies that can affect both the supply of transportation capacity and the demand for that capacity. Demand can be managed through taxes on automobile parking, for example.
- Move quickly to eliminate telecommunications network capacity bottlenecks, which are inherently easier to correct than transportation capacity deficiencies.
- Eliminate legal and technical barriers to innovative telecommunications utilization that would reduce transportation demand. For example, change laws that require in-person appearance rather than allowing for the faxing of documents as a trip substitute.
- Include land use regulation in the public policy mix, in order to influence the geographic patterns of residences, service delivery locations, and other employment sites that lead to transportation demand.
- Maintain institutional arrangements that put consideration of the deployment of telecommunications infrastructure and transportation infrastructure on an even footing. In the U.S., the attention of the Vice President to telecommunications infrastructure is a counterbalance to the influence of the well-established and well-funded Secretary of Transportation.

Those in charge of coordinating transportation and telecommunications policy need to work on developing more understanding about telecommunications-transportation interactions, and on disseminating this understanding to professional and political leadership. Then this knowledge needs to be joined with politically-acceptable public transportation goals in a policy-making process aimed at specific transportation outcomes.

Targeting of effort based upon a more thorough understanding of the relationship between telecommunications and transportation is an important requirement for decision makers in both the telecommunications and transportation sectors of developing nations. Without this understanding and focus, the deployment of more capable telecommunications infrastructure is likely to exacerbate present trends of worsening traffic congestion.

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THE NATIONAL COMMUNICATIONS SYSTEM (NCS): DESCRIPTION OF THE PLANNING FRAMEWORK AND PROGRAMS AND INITIATIVES TO SUPPORT EMERGENCY TELECOMMUNICATIONS REQUIREMENTS

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1. ABSTRACT

The National Communications System (NCS) is charged with developing a responsive, survivable, and enduring national telecommunications infrastructure that supports the National Security and Emergency Preparedness (NS/EP) needs of the Federal Government. The NCS uses a common planning framework to conceive, develop, and implement telecommunications capabilities. These capabilities work synergistically to support NS/EP telecommunications requirements across the threat spectrum. This paper discusses the NCS planning framework and resulting programs and initiatives that support NS/EP emergency operations.

2. INTRODUCTION

The National Communications System (NCS) assists in planning for and provisioning National Security and Emergency Preparedness (NS/EP) telecommunications for the Federal Government under all circumstances, including peacetime, crisis and mobilization, and recovery and reconstitution. The NCS provides key services and capabilities in support of emergency NS/EP telecommunications requirements. The NCS programs and initiatives are designed to leverage commercial telecommunications carriers assets, systems, and services; maximizing NS/EP telecommunications capabilities using resources of the public switched network (PSN).

Because the NCS relies on the PSN to fulfill NS/EP telecommunications requirements, it works closely with the telecommunications industry through the National Security Telecommunications Advisory Committee (NSTAC). The President's NSTAC consists of 27 senior corporate leaders representing major telecommunications industry carriers, manufacturers, information systems providers, and aerospace firms. The NSTAC provides advice and expertise to the President and the Executive Agent, NCS, on issues and problems related to implementing NS/EP telecommunications policy. NCS programs are responsive to the advice provided by the NSTAC as it applies to NS/EP requirements.

This paper is presented in two parts. The first part discusses the planning framework for analyzing NS/EP telecommunications requirements and conceives, develops, and implements NCS programs and initiatives. The second part describes how NCS programs and initiatives work synergistically to ensure that NS/EP users can access the PSN and the full complement of NCS-developed network enhancements to support NS/EP critical operations across the threat spectrum.

3. NCS PLANNING FRAMEWORK

To ensure the effectiveness and applicability of NCS programs and initiatives to support NS/EP emergency requirements, the NCS uses a planning process that provides a common framework for identifying, developing, planning, and implementing telecommunications concepts. The planning framework consists of the following steps:

- Analyzing NS/EP telecommunications requirements
- Assessing the telecommunications environment
- Performing shortfalls assessment
- Developing telecommunications enhancement and augmentation concepts
- Coordinating NS/EP requirements with industry
- Implementing telecommunications programs and initiatives
- Reassessing NS/EP telecommunications capabilities.

The specific steps of the planning framework are described below.

Analyzing NS/EP Telecommunications Requirements

NS/EP telecommunications are defined as telecommunications services that are used to maintain a state of readiness or to respond to and manage any event or crisis (local, national, or international) that causes or could cause injury or harm to the population, damage to or loss of property, or degrades or threatens the NS/EP posture of the United States. NS/EP telecommunications requirements identify specific telecommunications needs critical to the performance of emergency operations. These requirements are determined by the number of circuits and types of data, including voice and data, that are needed to perform NS/EP missions. The NCS regularly reevaluates NS/EP telecommunications requirements to assess changes in the number of users and in the types of services required for operations.

Assessing the Telecommunications Environment

The telecommunications environment includes the current capabilities of the telecommunications infrastructure and the threats that may interfere with or cause damage to that infrastructure. Current capabilities identify the assets used to meet the NS/EP telecommunications requirements of the Federal Government. The NCS investigates actual and planned Government networks and the PSN; together these networks constitute the national telecommunications infrastructure. During this investigation, the NCS collects specific network information from the Government and commercial telecommunications carriers to assess the current capabilities of the national infrastructure.

The NS/EP environment also includes the threat environment. NS/EP threats are characterized by both destructive and disruptive threats that may impede NS/EP telecommunications. These threats include technology and security risks, network congestion, and the full range of emergency situations including natural disasters, sabotage, terrorists attack, and limited and strategic nuclear warfare. The NS/EP environment also encompasses threats that may affect the Nation's economic posture. National emergencies and threats are both integral components of NS/EP telecommunications planning efforts.

Performing Shortfalls Assessment

The shortfalls assessment element identifies national telecommunications shortfalls in the existing capabilities that inhibit or preclude the satisfaction of NS/EP telecommunication functional requirements. The shortfalls can be identified through several methods, including modeling analysis.

In the modeling analyses, the PSN, including interexchange carriers (IEC) and the local exchange carriers (LEC) networks, is simulated as it is affected by various levels and types of damage. The levels and types of damage are selected based on experience from actual crises and emergencies, such as Hurricanes Hugo and Andrew, or expected damage based on various damage scenarios, such as terrorist attack. Current simulation models take into consideration logical and physical connectivity, and are able to quantify a variety of threats, including natural disasters and threats posed by members of the computer underground. Modeling tools include the Natural Disaster Damage Assessment (NDDA) model that determines the expected loss of telecommunications functionality from natural hazards. The NDDA has two parts: the first consists of developing fragility models for telecommunications systems and facilities; the second incorporates probabilistic modeling approaches. Based on the quantitative modeling effort, shortfalls are identified where NS/EP telecommunications requirements could not be met because of expected damage.

Developing Telecommunications Enhancement and Augmentation Concepts

Telecommunications enhancement and augmentation concepts are developed to mitigate identified shortfalls and provide enhancements to NS/EP telecommunications capabilities that benefit multiple Federal organizations. These concepts enhance interoperability and survivability, satisfy special or unique requirements, and include two broad-based enhancements: leveraging PSN assets and capabilities, and providing transmission augmentations. Together, these enhancements compose the National Level NS/EP Telecommunications Programs (NLP).

As the major component of the NLP, the Government Emergency Telecommunications Service (GETS) was developed to leverage IEC and LEC network capabilities. GETS provides NS/EP users with a dependable, cost effective, and flexible switched voice and voice-band data communications service that will be available under a broad range of damage caused by natural and man-made disasters and congestion. The GETS architecture is designed to take advantage of new and emerging technologies available within the PSN. This benefit allows greater flexibility for NS/EP enhancements and augmentations, and enables GETS to be more responsive to the changing NS/EP environment. The GETS encompasses the following features:

- GETS will use existing features and services of the PSN to provide a nationwide capability for switched clear voice, encrypted secure voice, and voice-band data communications
- GETS calls will be afforded expanded network capabilities, priority treatment, enhanced routing, and exemption from network management control restrictions in the PSN, and will provide additional routing for transmission augmentations
- GETS will be available both nationwide and from selected overseas locations through a special GETS access number and user authentication using personal identification numbers (PIN).

Other components of the NLP include the CNS and CSI programs. The CNS and CSI programs were developed to provide transmission augmentations. CNS enhancements improve diversity of NS/EP access and egress connectivity by integrating wireline and wireless emerging communications technologies. For wireless, the CNS program investigates how cellular communication can enhance NS/EP access to the PSN during disasters and works with industry to motivate the development of a cellular priority treatment scheme that will afford NS/EP users priority treatment during congestion. CNS wireline efforts investigate the development and application of competitive access provider (CAP) network capabilities. In addition, CNS, using mobile transportable telecommunications (MTT) assets, provides the capability to restore PSN links using military TRI/TAC radio equipment.

The CSI program uses commercial transportable and fixed satellite assets, and interoperates with the PSN to support NS/EP operations across the threat spectrum. Because of the inherent capabilities of satellite communications, CSI can effectively support deployed and disconnected NS/EP users, enhance the national and regional PSN connectivity, and support CONUS and international NS/EP users through dedicated satellite communications.

Coordinating NS/EP Requirements with Industry

Because the NCS relies on the PSN to fulfill NS/EP telecommunications requirements, the NCS coordinates those requirements with industry, encourages the development of certain capabilities and technologies, and works with industry to develop standards that take into consideration specific NS/EP requirements.

The NCS relies on the assets, services, and capabilities of commercial telecommunications carriers to provide NS/EP telecommunications enhancements. As a result, these enhancements, including both current NLP programs and initiatives being developed, depend on close coordination with industry to ensure that industry fully understands unique NS/EP requirements and that commercial capabilities can be enhanced to effectively support NS/EP requirements. For example, the NCS developed the Telecommunications Service Priority (TSP) program. The TSP program ensures that carriers can prioritize provisioning and restoration of NS/EP services if carrier assets providing NS/EP services become damaged or congested.

The NCS evaluates new and emerging technologies and capabilities to identify how these capabilities can improve NS/EP telecommunications. Although emerging technologies are primarily designed and developed for the marketplace, the NCS, as a major user of these systems, coordinates with industry to encourage the development of systems capabilities that can support NS/EP requirements. Currently, for example, commercial cellular carriers do not provide priority treatment services.' Based on analysis of recent disasters, such as Hurricanes Hugo and Andrew, the NCS identified the need for cellular carriers to expand their capability to provide NS/EP users with nationwide cellular priority treatment. Through formal working groups and informal discussions, the NCS and cellular carriers are working together to develop a common standard and service for cellular priority treatment.

The telecommunications industry relies on a common set of standards to ensure compatibility and interoperability in the marketplace. To ensure that standards are developed that enhance NS/EP telecommunications capabilities, the NCS, as a major user, participates in the standards development process. For example, the NCS has encouraged the development of the high probability of completion (HPC) standard. HPC is a American National Standards Institute (ANSI) standard that will be used by all carriers to identify NS/EP user calls and to ensure those calls benefit from the full extent of NCS-developed network enhancements.

Implementing Telecommunications Programs and Initiatives

Once telecommunications enhancement and augmentations are developed and coordinated with industry, the NCS incorporates those capabilities into the NLP. These capabilities can be enhanced services that are embedded in the PSN or can provide augmentations to the PSN. The services are implemented to ensure interoperability with each other and the PSN, and are also designed to be transparent to the NS/EP user. For example, for access to GETS, the NS/EP user dials the standard NCS GETS number, and a full range of independent services and augmentation are activated for call processing.

The programs and initiatives also use a common management structure. The National Coordinating Center (NCC), along with the National Telecommunications Management Structure (NTMS), provide a national framework to initiate, coordinate, restore, and reconstitute NS/EP telecommunications services or facilities under the all-hazards concept. The NCC, composed of representatives of the Government and industry, is responsive to the critical communications requirements of the Federal Government across the entire spectrum of crises or emergencies. The NTMS plays a crucial role within the NCS in ensuring that the functions performed by the NCC can continue under all circumstances.

Reassessing NS/EP Telecommunications Capabilities

The NCS reassesses NS/EP telecommunications capabilities on a regular basis to ensure the effectiveness of NCS enhancements and to identify new and emerging technologies that may improve NS/EP telecommunications capabilities. Each year, the NCS analyzes the PSN, including the IEC and LEC networks to quantify the effects of various evolving threats to NS/EP telecommunications and to confirm the enhanced performance offered by the NCS NLP programs. Based on the analysis effort, the NCS can identify changes in network vulnerabilities based on the changing threat environment and can identify NLP enhancements that require greater focus. For example, because of the changing threat environment and an increase in network robustness, the CSI program was reengineered to include fewer earth stations; however, program improvements were made to ensure that CSI can expand its capabilities to be responsive to natural disasters throughout all regions of the United States, including Alaska and Hawaii.

The NCS also investigates new and emerging technologies and capabilities to determine whether they can meet evolving NS/EP requirements and improve NS/EP telecommunications capabilities. In broad terms, the evolution of NS/EP requirements will mirror the use of commercial applications. For example, as the PSN migrates toward a broadband integrated services digital network (B-ISDN) environment and the asynchronous transfer mode (ATM) switching platform, and the use of broadband applications become standard, NS/EP requirements will extend past voice-grade services to more broadband-related applications, such as video imagery. As a result, the NCS investigates the migration plans for PSN carriers, participates in the standards process to ensure NCS requirements can be met, models broadband networks to identify potential shortfalls, and experiments with broadband applications to develop new capabilities to ensure that evolving NS/EP requirements are continually met.

4. NCS PROGRAMS AND INITIATIVES

The NCS provides a responsive, survivable, and enduring national telecommunications infrastructure to support NS/EP requirements across the entire threat spectrum. NCS programs and initiatives are designed to leverage PSN assets and capabilities and provide transmission augmentations that provide access diversity and enhance network connectivity. Overall, the programs and initiatives perform three fundamental functions:

- Provide NS/EP user identification
- Ensure PSN access
- Enhance NS/EP call completion.

Providing NS/EP User Identification

To ensure that NS/EP users can take advantage of the suite of enhanced network capabilities, there must be a mechanism within the PSN to identify NS/EP user calls. As a result, the GETS program developed a methodology to identify NS/EP calls. The methodology uses the HPC standard as the signalling message to carry the NS/EP identifier end-to-end.

HPC is an approved ANSI standard that provides a unique identification code for NS/EP calls and a higher priority level within the signalling network. By associating the HPC parameter with the call, the call is assured the full complement of network enhancements as it accesses and egresses the PSN. The HPC parameter is set by originating a call from a designated NS/EP facility or by dialing the NCS 710 numbering dialing plan area (NPA) code.

The NCS encouraged the development of and owns the 710 NPA. The 710 NPA is a non-geographical NPA; users can dial the designated 710 number, a PIN, and the destination number from any location. Once the designated 710 number is dialed, the HPC parameter is set and the call is identified as an NS/EP call. The call is then authenticated by a PIN and routed based on the destination number.

Ensuring PSN Access

Threat analyses and recent emergencies have demonstrated the vulnerability of landline access to the PSN as a result of damage and congestion. In response, the NCS has developed and implemented CNS and CSI transmission augmentations to ensure NS/EP users can access the PSN across the threat spectrum. NCS transmission augmentations provide access and technology diversity to the PSN, and include CAP augmentations, cellular communications, transportable satellite communications, and mobile satellite services (MSS) capabilities, when MSS is available.

Transmission augmentations can either enhance existing or planned commercial capabilities or provide dedicated circuits. For example, through the CNS program, the NCS is encouraging the development of priority treatment schemes in existing cellular networks and MSS systems, once MSS systems are implemented. In addition, the CSI program provides dedicated satellite circuits to connect NS/EP users from the disaster location to undamaged portions of the PSN through a remote PSN access capability.

Enhance NS/EP Call Completion

Once the NS/EP user call has been identified and has accessed the PSN, network enhancements implemented by the GETS program ensure the call can be completed. Although there are a wide variety of network enhancements, they can be categorized based on four basic functions:

- Remove restrictive network management controls
- Employ expansive network capabilities
- Provide priority treatment
- Provide enhanced routing.

Call completion for NS/EP calls can be enhanced by removing restrictive network management controls. Network management controls are designed to prevent or control degradation in the quality of network service. Two examples of network management controls are call blocking and call gapping. During the Loma Prieta earthquake, the LEC blocked all egress calls to relieve network congestion. In this case, NS/EP calls having the associated HPC parameter would have been exempt from call blocking, ensuring call completion. In addition, by removing restrictive network controls, NS/EP calls can avoid the effects of call gapping where the network drops a percentage of calls to relieve congestion.

NS/EP calls can also be afforded expansive network capabilities. Expansive measures generally increase routing choices by providing more capability than normal to carry excess traffic. For example, the NCS uses enhanced real-time network routing (E-RTNR), an AT&T expanded service that allows NS/EP calls to traverse network routes that are not normally available. Therefore, NS/EP calls have more alternate routes available to avoid the affects of network damage and congestion.

Priority treatment can also be given to NS/EP calls. Priority treatment can be administered in several ways. Service arrangements can be arranged that ensure that a small number of customers, designated as essential users, receive first priority dial tone. In addition, priority treatment can be administered through priority trunk queuing. Priority trunk queuing consists of identifying specific users as priority users, and then, during congestion, placing those users at the front of the queue for the next available outgoing trunk.

Finally, NS/EP calls can be provided with enhanced routing. The NCS provides enhanced routing through embedded network features and transmission augmentations. Enhanced routing, using embedded network features, is the ability of the network to select alternate paths in the network to route traffic to its destination when the primary route is congested or out of service. For example, dual hosting provides two diverse connections to the PSN using two different switches. When one line is damaged or congested, dual hosting provides the capability to failover to the alternate line and switching component. In addition, the NCS developed transmission augmentations to enhance connectivity. For example, through CSI satellite augmentations, the NCS can provide a diverse, dedicated routing within the network to enhance overall connectivity alleviating the effects of damage and congestion.

5. SUMMARY

The NCS provides telecommunications enhancements and augmentations to support NS/EP requirements. To ensure the effectiveness and applicability of NCS programs and initiatives, the NCS uses a common planning framework to identify, develop, and implement telecommunications capabilities. This framework, and the resulting programs and initiatives, can be translated to other countries, including lesser developed countries, to enhance their telecommunications infrastructure and to support their emergency telecommunications requirements.

SATELLITES TO THE RESCUE

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1. ABSTRACT

When normal communications are disrupted, business and government often come to a standstill. When communications are disrupted due to an emergency or disaster, loss of life and suffering result. The job of the communications professional is to be able to provide immediate or near-immediate restoration capability, at a cost which can be afforded by the organizations needing such restoration, be they government, private or personal. This paper examines how communications via one satellite system, Inmarsat, has become one of the principle means of providing for emergency communications.

2. SUMMARY

One of the principle reasons for the creation of the International Maritime Satellite Organization (Inmarsat) was to provide for the safety of life at sea. Unknown to the framers of the Inmarsat Convention was that a far greater use of the system would be to provide for safety of life on land. In the 18 years since the start of services through the Marisat system, a significant number of instances have shown that rapidly deployable Inmarsat user terminals are capable of providing the necessary communications capability to enable rescue workers and government agencies to more quickly obtain the resources needed to stabilize conditions in areas of natural or man-made disasters. Natural disasters in which Inmarsat terminals have been deployed include earthquakes, forest fires, mud slides, hurricanes, and drought areas. Man-made examples run the gamut of strikes, wars, civil unrest, oil spills and police actions.

The extensive use of Inmarsat has been due to a combination of its global availability, rapid deployment capability, interconnectivity and ease of use. Tied to this are the additional attractiveness of the variety of services (voice, data and fax), and avoidance of large investments. In addition to the satellite units themselves, the capability now exists to deploy transportable cellular systems which can be interconnected to the Inmarsat equipment, giving both a local and global communications capability. This has enabled governments, inter-governmental organizations such as the United Nations, and private corporations to consider the use of Inmarsat as its first response to establishing communications in emergency situations. Planning is now being conducted on a regional basis, with pooling of equipment amongst possible affected areas, such as the island nations of the Caribbean.

The paper concludes that planned future services assure continued expansion of the use of satellites for emergencies. Satellites will fulfill the role of **The Missing Link**, the theme of this year's conference. The development of aeronautical integrity services using spread spectrum will be important for the aviation industry. Inmarsat-C was developed to help provide for global maritime distress and safety service (GMDSS), automated vehicle location (AVL) and tracking service, and supervisory control and data acquisition (SCADA). Use of differential GPS will permit greater safety of navigation in waterways, and the near term implementation of an international paging service will permit users to receive life-saving information from a world away. All of this is accompanied by development of lower-priced equipment and communications costs such as provided by the new standards M and B and the proposed Inmarsat-P service.

3. EMERGENCY COMMUNICATIONS

Several thousands of years ago, some of the earliest forms of emergency communications were the use of visual aids such as fire (lighthouses and smoke signals) and mirrors, or acoustical means such as tom-toms in the jungles of Africa or bells in towns around the world. Things evolved slowly, as we saw in the 1700 and 1800's when lanterns were hung in old church towers (one if by land, two if by sea), and flag signals were used between ships. Ships and the ocean, in fact, paved the way for the more modern types of communications to be used, when the passenger ship, the Titanic, sank after hitting an iceberg on April 14, 1912. As a result of that disaster, nations of the world later convened an international conference and eventually created the International Maritime Consultative Organization (IMCO), now known as the International Maritime Organization (IMO). A protocol known as the SOLAS Convention (Safety of Life at Sea) was drafted and agreed. Amongst other things, the use of HF radio telegraphy was made mandatory for ships on the high seas, as well as monitoring of radio frequencies to assist in emergencies. This technology ruled the oceans for over 60 years until the MARISAT system was launched in 1976, and satellite communications became the wave of the future. The capsizing of the offshore drilling rig The Ocean Ranger in 1982 brought to the forefront the importance of high quality satellite communications during critical emergencies to reduce the loss of life and property.

Emergency communications on land differ from those at sea and have evolved from being strictly a means of alerting others of a crisis to incorporating the functions of assessment and reconstruction. The circumstances under which an emergency occurs have much to do with the form of communications to be used. Factors which impact this are the suddenness of the event (expected vs. unexpected, such as a hurricane as compared to an earthquake or forest fire); the size and location of the area involved and the size of the affected population; natural disaster vs. manmade; and the pre-existing communications infrastructure. Interestingly, one of the first signs of a problem in populated regions is the loss of normal means of communications. Loss of television or radio reception or other forms of communication alerts us to a disaster. Even difficulty in communications in lieu of complete loss is a signal, as many of us learned in the period following the assassination of President John Kennedy when telephone lines became severely congested as people called others to tell them of the tragedy.

The establishment or restoration of communications for emergency situations requires consideration of several variables as follow:
To where should communications take place to request help? What type of help is required? How much and how soon? How can communications be initiated? How quickly, and at what cost? This, in turn, has resulted in the establishment of contingency planning, particularly by both governmental agencies and the more sophisticated corporations who realize that such plans can save lives as well as costs.

Initial communications requesting assistance must generally be made to areas outside that affected by the emergency. Where the infrastructure has been disrupted, the quickest, surest way to get word out is via satellite. Without question, the unanimous answer is to use the Inmarsat system. Normally, equipment becomes available from local users who either have it on hand, or it is brought in by relief organizations whose purpose is to assist in emergencies. At this point, there is not serious concern about costs, but in developing an assessment of damage. Depending upon the overall situation, this equipment may be used for very short periods, or extended due to complete devastation of the infrastructure. For instance, in the Florida and Hawaii hurricane disasters of 1992, Inmarsat equipment was used for a period of not more than a week, until the pre-existing networks could be supplemented by replacement facilities. In Florida, in addition to the use of satellite equipment, transportable cellular systems were brought in to provide for local communications. In Kuwait, where the whole communications infrastructure was destroyed during the Gulf War, several hundred Inmarsat units were permitted to operate for six months or more until other sufficient capacity became available to satisfy communications requirements. AT&T and others provided full replacement systems to reestablish close to normal communications, including switches and temporary Intelsat earth stations.

4. INMARSAT AND EMERGENCY COMMUNICATIONS

Only a handful of organizations can claim that one of the primary reasons for its existence is to provide for emergency communications. The Inmarsat Organization points to its governing international convention which originally stated that one of its primary purposes is to provide for communications for distress and safety of life at sea. As the Inmarsat charter was expanded to cover both land mobile and aeronautical satellite communications, this clause was expanded to include aeronautical service, in recognition of the importance of Inmarsat's global networking capabilities. However, even though safety of life on land is not yet formally acknowledged in the Inmarsat Convention as a purpose of the Organization, by far the greatest use of emergency communications has come from the land environment, which is to be expected because that's where the vast majority of population is located.

Communications transmission equipment must be licensed in most, if not all countries. This poses a problem particularly for land mobile users, in that any equipment must have approval of the host government before it can be used. Fortunately for the news media and others associated with emergency and restoration efforts, the licensing/approval requirements are frequently

waived. This is often accompanied by mass confusion, which actually helps the process due to ignorance of the laws by those who are placed in positions to control entry into a country.
As technology has evolved, Inmarsat has been able to provide additional uses of its system for distress and safety of life needs. The original Standard-A user terminals are now installed on over 16,000 ships and another 6,000 land-based locations registered in over 140 countries. The Standard-C data terminals, which enable exchange of messages using store and forward techniques, have been specifically approved by IMO for GMDSS (Global Maritime Distress and Safety Service) and are located on more than 6000 ships and are available at another 3000 land-based stations worldwide.

The availability of the new Inmarsat-M technology creates an opportunity for greatly expanding Inmarsat's role in disaster planning and relief. This new digital technology has resulted in lower priced end-user equipment, of lighter weight and portability, and enables good quality communications at approximately one-half the cost of the previous universally-accepted Standard-A equipment. This then enables more relief planning agencies to purchase their own equipment, thus assisting rescue operations and permitting even quicker reporting and assessment of damages to external parties, reducing chances of potentially duplicative efforts and initial confusion regarding the extent of the emergency.

The even more recent Inmarsat-B service involves a higher quality voice and data service. Although not as light and portable as the Standard-M equipment, it is on a par with the -A units insofar as weight, but much less expensive for service. The multi-channel capabilities of both -B and -M terminals will result in even lower costs for communications, and can serve very suitably with portable cellular systems, thereby permitting a temporary local service to interconnect with a wide-range international network.

Aeronautical satellite service is also only just beginning, but substantial preplanning went into the development of the way in which Inmarsat service would be provided to aircraft, involving FAA and CAAs of other countries, ICAO, RTCA, ARINC, airline operators, manufacturers, and a whole alphabet of other organizations to establish standards of operation for various types of communication, including those related to safety, such as ATC (air traffic control) and AOR (airline operational control), which can be done with both data and voice reporting. While only a small number of aircraft have actually tested the services, the industry is extremely enthusiastic about its potential, and expect all or most international jet aircraft to be equipped.

Even though many of these services are new and just beginning, more are on the drawing board, with paging, spread spectrum differential GPS service, and others nearing implementation. Under very active consideration is the planned Inmarsat-P effort, which envisions the use of hand-held user terminals, expected to be available in the late 1990's, and is expected to fill many voids which exist today for distress and emergency communications, at lower prices for both hardware and service.

5. USERS AND APPLICATIONS

A large number of state, national and international organizations have obtained Inmarsat equipment for emergency communications. State police units and volunteer rescue organizations have already obtained equipment and are often amongst the first to arrive to assist in relief work. At the national level, FEMA (Federal Emergency Management Agency), law enforcement agencies, and defense units have obtained and deploy equipment in a multitude of cases. International organizations such as UNDP, the Red Cross and Pan American Health Organization have incorporated Inmarsat communications into their emergency contingency plans. Embassies of many countries around the world are now equipped to use Inmarsat when other forms of communication are disrupted. There has even been equipment and holding it for use by member states in the region, such as the Caribbean island states. A number of organizations are now also in the business of leasing and deploying hardware to others who need its use for a short term period, and can either avoid outright purchase, or supplement the inventory of equipment available.

One of the great features of the Inmarsat system is the ability to use voice encryption techniques to protect the integrity of information. This feature, coupled with the capability to transmit facsimile messages and computer data via satellite, makes the system's services invaluable to its users.

At the corporate level, many companies are now obtaining units to place at overseas remote locations to provide communications in the event of disruption of service for any number of reasons, including strikes, civil disturbance and natural disasters. As the price of equipment continues to drop, more and more international companies will purchase this form of insurance.

6. CONCLUSION

With the cost of equipment and services continuing to decrease with advances in technology, the planning for emergency communications becomes easier, with many more public and private organizations able to purchase the capability which will be invaluable in saving lives and property. The Inmarsat Organization and its members have shown repeatedly that their global satellite service will be an important tool in fulfilling that mission. Steps are being taken to widen the capabilities and availability of equipment and services for the future.

LASCOM-NET
(Japan Local Authorities Satellite Communications Network) For Disaster Prevention and Administrative Communications

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ABSTRACT

An expanded telecommunications network will make the world a better and safer place as mentioned in the 1984 Missing Link. An increase in investment in a telecommunications network directory relates to the state of national economic growth. However, a telecommunications network for disaster prevention and administrative purposes should be constructed with a higher priority. Therefore, it is considered that it would be better for a telecommunications network, for disaster prevention and administrative purpose, to be publicly owned and privately used by local authorities. This paper introduces the LASCOM-NET network for disaster prevention and administrative purposes in Japan.

1. INTRODUCTION

(1)This paper introduces the Japan Local Authorities Satellite Communications Network (LASCOM-NET) for disaster prevention and administrative purposes paying attention to the following important considerations-:

1. An expanded telecommunications network will make the world a better and safer place. (Executive summary 4)
2. Telecommunications play an essential role in emergency and health services and in public Administratio. (Executive summary 7)
3. The choice of technology: analog or digital technology : satellite or radio system (Executive summary 20)
4. It is for governments to decide whether telecommunications should be publicly or privately owned, and whether competition should be admitted. (Executive summary 23)

(2)In recent years, Japanese telecommunications have been vigorously expanded basically because it has been recognized that such expanded telecommunications services would make the world a better and safer place The very significant Japanese investment in its telecommunications services has also resulted from the strong economic growth in Japan, over the same period mentioned above. However, if we turn around and reconsider the role of the telecommunications in the country we will see that telecommunications for disaster prevention and administrative purposes are extremely important and should have a higher priority than those provided for private communications and economic activities. During 1993, there were many abnormal meteorological phenomena, specifically extremely heavy rainfall, a very chilly summer, and many typhoons as well as the disasters of an earthquake and tsunami in Southwest Hokkaido, Japan. During such disasters, there were an increased number of calls on the public telephone network from friends and relatives worrying about their families safety and well being and the number of lost or mis-connections increased significantly.

(3)This paper describes the purpose, situation, system construction, technical data, scale, applications and features of the LASCOM-NET network which has recently been established in Japan and is now being expanded. The Japanese Government decided that the network should be publicly owned with its primary objective being to provide a telecommunications network for disaster prevention. The secondary objective being to provide a telecommunications network for administrative use in operational training to ensure effective use is made of the system during disasters when the normal public telecommunications network is not available. The main features of the network, in addition to usual communications of voice, facsimile, data, video (analog and digital), packet type data and teleconference, are as follows-:

1. Simul command system: Each local government has a broadcast type simul command channel with an acknowledgment signal sent by the receiving operator either providing manual or automatic confirmation.
2. A Hot-line Set Up system: To set up calls quickly without dialing
3. Prior communication system: To maintain pre-assigned exclusive channels to disaster area.
4. Forced line cut off system: To maintain emergency communication channels and digital video transmission services to disaster area.
5. Health check function: Allows the central station to automatically monitor all the participating station by a polling method.
6. Congestion control function: Using a DAMA system at the central station

2. LASCOM-NET

2.1 BACK GROUND TO JAPAN LOCAL AUTHORITIES SATELLITE COMMUNICATIONS ORGANIZATION

A disaster-preventive telecommunication system plays an important role in contingency planning and Japanese Disaster Prevention Radio Communication Network (DPRC-NET), which consists of terrestrial microwave radio links and mobile radio systems. DPRC-NET operates in accordance with the different levels of communications used by the national, prefectural and municipal governments in Japan. For the past decade or more, various proposals and studies have been put forward for integration of satellite communication systems with the existing DPRC-NET to enhance and extend the services. Anticipating the 21st Century, and the high level information-oriented society that will exist then, the Government privatized the national telecommunication services and approved the launching of private communication satellite system in Japan. With the above governmental policies and the need to replace existing communication equipment a decision was made to incorporate a satellite communication system into the existing DPRC-NET. The Japan Local Authorities Satellite Communications Organization (JLASCO) was founded as an operational body of the Japan Local Authorities Satellite Communications

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Network (LASCOM-NET) by all local authorities in Japan on the 19th of February, 1990, under the joint control of the Ministries of Home Affairs and Posts and Telecommunications. JLASCO is responsible for the LASCOM-NET network, which provides a national disaster preventive and administrative communications network. Transponder of the domestic communication satellite is commonly used by almost all the local authorities in Japan that participate in the network with the payment depending on the usage of the network. JLASCO has been in operation since the 1st of December, 1991 with three local authorities owning 130 earth stations, and many other local authorities joining in and constructing additional earth stations with a maximum of over 5,000 earth stations planned for the future.

2.2 PURPOSE and OUTLINE

(1) The main objectives of this network are summarized below-:

Enhance and extend the existing DPRC-NET network

Provide communications for the administrative authorities

Transmission of information from each local areas.

The network will be widely used by each of the following agencies with a total number of 5,000 earth stations planned for the year 2001.

National, Metropolitan and District Authorities and cities which have been specified by Governmental Ordinances, and Municipal Authorities.

Disaster prevention agencies

(2) The conditions for construction of the network are as follows-:

Coordination with existing anti-disaster administrative radio networks

To provide complementary networks with existing networks for emergency and rescue communication services

To make as many practical applications as possible available for general administrative purposes

(3) Functional Outline This network is controlled and managed by the central station. Unless specified all the following sub-central station functions are also provided by the central station.

(4) Satellite and transponders

The network uses a Super-bird B satellite with Ku-band transponders. Two and one transponders will be used two for digital services and one for analog services in the final stage, respectively.

2.3 SERVICE CONTENT

The concept of the network, classifications, functions, and service menu of the earth stations in the network are shown in the followings:

Figure 2.1 CONCEPT OF THE NETWORK

Table 2.1 SERVICE MENU AND TYPE OF EARTH STATIONS

All the above voice, facsimile, data, simul command and analog video services are standard services which are provided as part of an overall nation wide service. Analog video and digital video signal transmission and receive service are also provided as part of an overal nation wide service but only at the request of the local Metropolitan or District Governments. Packet type data services are limited to the Metropolitan and District areas and this service is also only provided at the request of the local Metropolitan and District Governments. The Service Menu, provided with every channel, is summarized below. And the bills, for satellite channel usage, is sent to the Metropolitan and District governments monthly.

(1) Voice, facsimile and data

(Individual communications channel) The channels for transmission of voice facsimile and data signal (these services are also referred to as individual communications,) use a Demand Assignment Multiple Access (DAMA) system. The DAMA system consists of DAMA control equipment at the central station, and Channel Control equipment at each earth station. Channel assignment of individual communication is controlled by DAMA control equipment using a dedicated channel assignment control channel. Prior assignment is requested by the telephone or facsimile to the central station.

(2) Simul command channel (voice and facsimile)

Every channel, allocated for the dedicated broadcast type simul command services and the return acknowledgment services, is determined at the central Tokyo station and at each Metropolitan and District Earth station. The respective Transmitting Earth Station is responsible for confirming all the incoming acknowledgment responses and overall management of the service. Requests or simul command to the Tokyo Central Earth Station or the Metropolitan and District Earth Stations, from stations which do not have a facsimile simul command function, can be accommodated depending on the decision of each district public agency.

(3) Packet type Data Channel

Each Metropolitan and District station can provide packet type data channels according to request. In this case, the network will operate as a both way startype network, with the master stations at the Metropolitan and District Stations and Terminal stations as branch stations of the respective Metropolitan and District Stations. However, the central station is responsible for the maintenance of the packet type data channel facilities and additional maintenance management equipment is required at the master station. As it is also advisable to monitor the terminal stations, the maintenance management equipment, at the central station, should also have control and channel monitoring facilities.

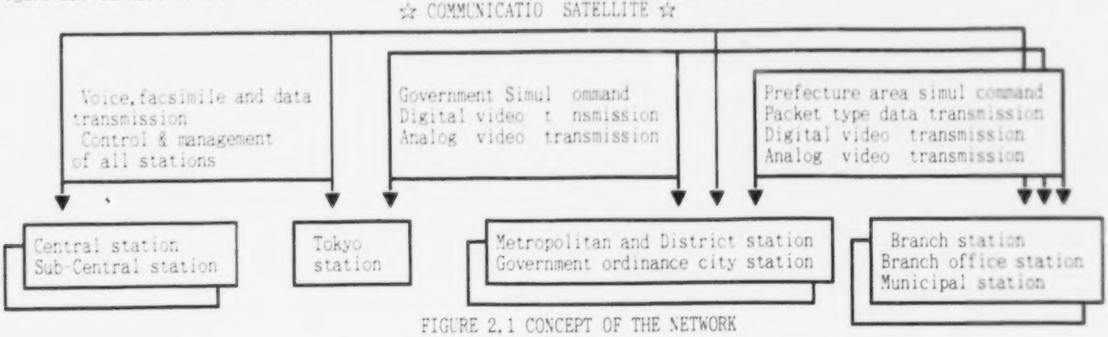
☆ COMMUNICATIO SATELLITE ☆
Voice, facsimile and data transmission
Control & management of all stations
Government Simul ommand
Digital video t nsmission
Analog video transmission
Prefecture area simul command
Packet type data transmission
Digital video transmission
Analog video transmission
Central station
Sub-Central station
Tokyo station
Metropolitan and District station
Government ordinance city station
Branch station
Branch office station
Municipal station

FIGURE 2.1 CONCEPT OF THE NETWORK

TABLE 2.1 SERVICE MENU AND TYPE OF EARTH STATION (*:OPTION)

Types of earth station	Service / Location	Voice,facsimile and data (Individual communications channel)		Simul command of voice and facsimile (and data*)		Packet type data*	Analog video	Digital video
		Communication	Control	Tokyo command	Headquarters (Branch) command			
Central STN	Yamaguchi city	TX & RX	Assign				RX	RX
Sub-central STN	Bibai city	TX & RX	Assign				RX	RX
Tokyo STN	Tokyo	TX & RX	Request	command			TX & RX	TX* & RX*
Metropolitan and District STN	HQ of Metropolis and Districts	TX & RX	Request	Receive	command	TX & RX Master	TX & RX	TX & RX
Government ordinance city STN	Office of Government ordi.cities	TX & RX	Request	Receive	Receive	TX & RX	TX & RX	TX & RX
Branch STN	Office buildings	TX & RX	Request		RECV(CMND*)	TX & RX	TX* & RX	TX* & RX*
Branch office STN	Branch offices	TX & RX	Request		RECV(RECV*)	TX & RX	TX* & RX	TX* & RX*
Municipal STN	Cities &Villages	TX & RX	Request		RECV(RECV*)	TX & RX	TX* & RX	TX* & RX*
Fire fighting Disaster prevention agency STN	Fire fighting & disaster prevention agencies	TX & RX	Request		Receive	TX & RX	TX* & RX	TX* & RX
Mobile STN		TX & RX	Request				TX & RX	TX* & RX*
Public agency STN	Public agencies						RX	

(4) Analog video channel
Prior reservation of data,time and frequency band should be made to the central station either by telephone and/or facsimile, for analog video transmission services. Only after obtaining approval from the central station the analog video channel can be used. The central station manages the reservation requests and monitors the video transmission. Scrambled video signal can be used if scrambling equipment are available at the stations.

(5) Digital video channel
The transponder used for digital video signal transmission is also commonly used for individual communication channels. The frequency is also assigned by reservation with the date,time and type of communication advised to the central station so that the central station can assign the operation channel.

(6) Others
DAMA control equipment is not only used for the assignment of each communication channel but also for the prior assignment of channels for disaster stricken area and for control of assigned channel for digital video transmission. The DAMA equipment also includes the network control function in addition to the channel assignment and network management functions. The network management functions include statistical traffic data,channel operating conditions and the maintenance management function for control and information data gathering from each station.

2.4 ADMINISTRATIVE COMMUNICATION AND DISASTER PREVENTION NETWORK FOR THE METROPOLITAN AND DISTRICT AUTHORITIES

The existing administrative communication and disaster prevention radio communication network consists of a line of sight network, so the relationship between the satellite network and the line of sight network or the network configuration has been generally designed as follows. If the network uses the line of sight network, then the system design must be approved by the Ministry of Posts and Telecommunications.

TYPE-1: Overall network for administrative communication and disaster prevention including of a satellite network,excluding a mobile system.

- Mobile (administrative communication and disaster prevention) network : Line Of Sight network
- Other network : Satellite network

Stations are installed at every disaster prevention agency location, such as at the headquarters of the Metropolitan and District Authorities and also at the branch offices of the Metropolitan,District and Municipal Authorities.

TYPE-2: A Satellite network is used to complement the Line Of Sight disaster prevention network of the Metropolitan and District Authorities to improve the reliability of the network and provide additional functions for the network. This type of network is categorized by the four different types.

TYPE-3: Combined Line Of Sight and Satellite Networks have the following disaster prevention functions-:
Trunk line : Line Of Sight network
Terminal line: Satellite network
Earth stations are provided at the headquarters of the Metropolitan,District and Municipal Authorities Offices and it is possible to provide communications between the branch stations and the Municipal Offices via the headquarters using the earth stations at the Metropolitan and District Offices.

TYPE-4: The satellite network is used by the headquarters of the Metropolitan and District Authorities as a nationwide administrative communications network. And, the Line Of Sight network is used for the disaster prevention network. The typical type of Type 2 configuration is shown in Figure 2.2.

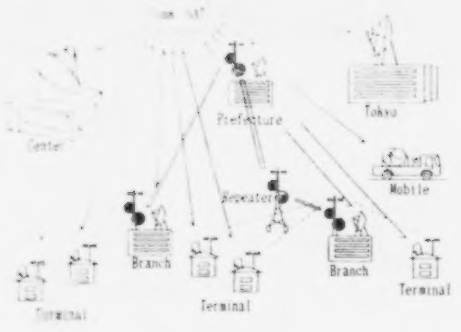

Figure 2.2 SYSTEM CONFIGURATION OF TYPE2

2.5 PRESENT CONDITION OF THE SATELLITE NETWORK

(1) Stations
130 earth stations, shared by three Metropolitan and District Authorities, began operations when the central earth station started operation on the 1st of December, 1991. The network as of July 1993 includes :

Under operation :14 Metro. and District Authorities
Number of stations: 1200 earth stations
Under construction: 8 Metro. and District Authorities
Under design : 7 Metro. and District Authorities
Under planning : others

(2) Calls
There was an earthquake off the Southwest coast of Hokkaido on the 12th of July 1993 and the 13th typhoon on the 3rd of September 1993. The calls during both these disasters are shown in Figure 2.3.

2.6 INITIAL INVESTMENT and OPERATING EXPENSES

(1)LASCOM-NET network is employing and operating by the local authorities which bear part of the initial capital investment and operating expenses.
(2)Initial cost of installation
JLASCO arranged the central station, sub-central station and Tokyo station with about 3 billion Yen, including the civil engineering and constructions, during 1990-1991. The system in each Metropolis and Districts, as a part of LASCOM-NET network, depends on the Metropolitan and District government decision.

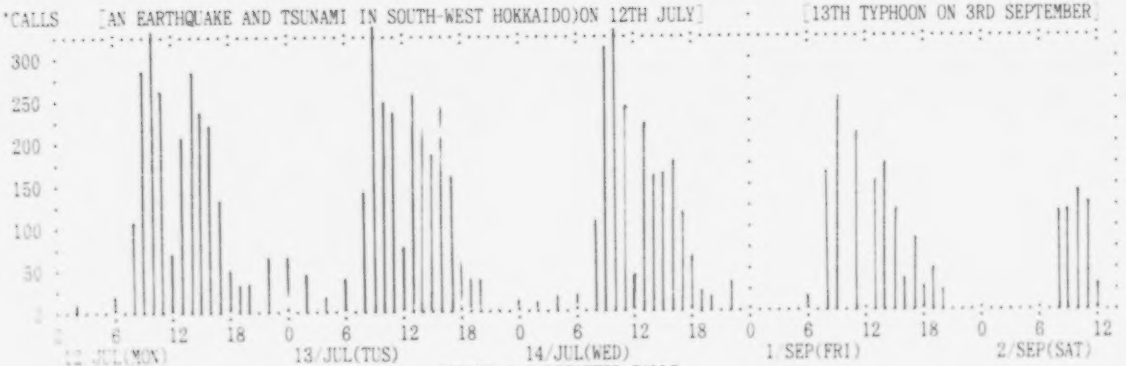

FIGURE 2.3 DISASTER CALLS

3. TECHNICAL DESCRIPTION

This chapter provides a technical descriptions of the [illegible].

3.1 COMMUNICATIONS MODE

The LASCOM-NET network consists of various channels, which are listed below, to provide the services described in chapter 1.
(1) Communication Channels
Individual communications channel for voice, facsimile and data (32kbps ADPCM coding signal)
Simul command channel
Analog video channel
Digital video channel
Packet type data channel
(2) Control Channels
Channel control channel
Simul command channel
Earth Station control channel

The communications channel modes are shown in Table 3.1 and the control channel modes are shown in Table 3.2. The main control and monitoring channel is explained below.

(1) Channel Control Channel
This control channel is mainly used for the assignment of the transmit and receive frequencies used with the individual communications channel. This channel connects all earth stations with the central station, and is also used to check on the operational condition of each station, called the HEALTH CHECK, from the central station. The transmit and receive channel equipment, used for Channel Control Channel, is commonly used by the channel unit for individual communications. Each individual communication channel unit, used by the Municipal Authorities earth station, is operated like a VSAT type system and must be controlled by the control channel from the central station which corresponds to the hub station in the LASCOM-NET network.

TABLE 3.1 GENERAL DESCRIPTION OF COMMUNICATION SYSTEM OF EACH CHANNEL

Satellite channel / Communication system	Individual Communication channel	Simul command of video and facsimile (and data*)		Packet data (example)		Analog video	Digital video
		Uplink	Downlink	Uplink	Downlink		
Multiplex System	DA-FDMA	PA-TDMA	PA-TDMA	PA-TDMA	PA-TDMA	PA-FDMA	PA-FDMA
Modulation	QPSK(burst)	QPSK(burst)	QPSK(cont.)	QPSK(burst)	QPSK(cont.)	FM	QPSK(cont.)
Information transfer speed(data trans. Speeds)	32kbps(70)	32kbps(70)	32kbps(70)	64kbps(128)	64kbps(128)	4.5MHz max. f	64kbps(128) 384kbps(768)
Error correction	convolutional coding(coding rate 1/2, word length 7) Viterbi decode*						same as *
Encryption						S-sys.	
Coding system	32kbps ADPCM		32kbps ADPCM			NTSC	CCITT

TABLE 3.2 GENERAL DESCRIPTION OF CONTROL SYSTEM OF EACH CHANNEL

Satellite CH / Communication system	Channel control channel		Earth station control Ch	
	Uplink	Downlink	Uplink	Downlink
Multiplex System	RA-TDMA	PA-TDMA	RA-TDMA	PA-TDMA
Modulation	QPSK(burst)	QPSK(cont.)	QPSK(burst)	QPSK(cont.)
Information transfer speed(data trans. speed)	32kbps(70))	32kbps(70)	32kbps(70)	32kbps(70))
Error correction	convolutional coding(coding rate 1/2, word length 7) Viterbi decode			

(2)Simul Command Channel

This channel is used for the simul command from the station at the Metropolitan and District headquarters office or by the station at the Branch offices using the downlink channel. It is also used for the forced channel operation prohibit control function. The uplink channel is not only used for transmission of the acknowledgment signal to the simul command signal but also for transmitting data gathering of operational conditions (e.g., alarms) of the channel units at each station to the station at the Metropolitan and District headquarters. The simul command receiver channel units of the stations at the Municipal offices are also controlled from the master stations at the Metropolitan and District offices. As mentioned above the individual communication channel unit is controlled separately.

(3)Earth Station Control Channel

This channel is used to control the signal transmission channel which transmits the control signal and information such as the forced communication operation prohibit signal to each earth station. It is needed for network operation from the central station via the Metropolitan and District stations. The earth stations, which are controlled by the Metropolitan and District stations, are connected with each other through the simul command channel. The control signal, for the forced operation prohibit command, from the central station to each Municipal station, is transferred through the earth station control channel and the simul command channel via the Metropolitan and District stations.

3.2 BASIC COMPOSITION OF 32 kbps SIGNAL TRANSMISSION

Transmission equipments, with 32 kbps transmission capacity, is used for individual communications, simul commands and transmission of other signals used in various parts of the network. In this section, the basic composition of the common hardware, used in the network, are specified. The transmit signal used in the system are described below-:

① B' channel signal (32kbps)
② D' channel signal (total 1.0kbps)

These two signals are multiplexed, scramled and, after adding error correction code, converted to the 70 kbps frame signal, and then converted to the four Phase Shift Keying (QPSK) signal. The modulated output signal is converted to the specified transmit frequency by the synthesizer with frequency steps of 50 kHz.

At the receive side, the incoming signal is down converted by the synthesizer, with the same frequency step size as that of the transmit side, to the specified receive frequency. This demodulated signal is then synthesized by the receive frame signal, the error correction signal extracted and the modulated signal de-scrambled leaving the original B' and D' signals to be separated from the receiving signal.

The signal multiplexing and the format for the transmission channel are together with the B' channel and D' channel transmit data which will be separated by a 20 msec time interval and separately time division multiplexed to the 640 bits and 20 bits blocks. These data are scrambled and an 8 bits postamble portion is added to the data. An R=1/2 coding rate is to produce the two (P and Q) data streams.

Both P and Q channels are multiplexed with a synchronized 32kbps signal and applied to the QPSK modulator. The QPSK modulated signal can transmit 2 bits per one symbol so the information bits of block and symbol rate after modulation are the same.

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3.3 CHANNEL AND FREQUENCY SETTING

1)Channel abbreviation
Individual communications are DAMA controlled and, several channels are required for the monitoring and control of the network. The following abbreviations and postscripts are used to categorize the type of channel in the following sections.

A or a :Individual communication channel(Voice=Audio, facsimile and data)
B or b :Simul command channel(Broadcasting type)
C or c :Channel control channel
D or d :Dedicated channel
E or e :Earth station control channel

The frequencies used for these channels are indicated by "fac" and "fba'".The letter which follows letter"f" indicates one of the above mentioned channels and the last letter or ['] identifies the type of frequency setting. An example: fac

→ c:Frequency assignment mode
a:Individual communication channel

The relationship between each transmission line and network is shown in Figure 3.1.

(2)Frequency setting
At least three frequencies are specified for the transmit and receive equipment. And "*" identifies the type of channel which is shown above (1).

f*a:Basic receive frequency
This frequency is the basic assigned frequency used for control from the central station, and is locally set to an assigned number "na" by an authorized operator at the earth station.

f*b:Spare receive frequency
This frequency is the backup frequency of f*a, and the channel number "nb" is downloaded from the central station using the "f*a" control channel. After being downloaded initially the frequency is maintained electrically.

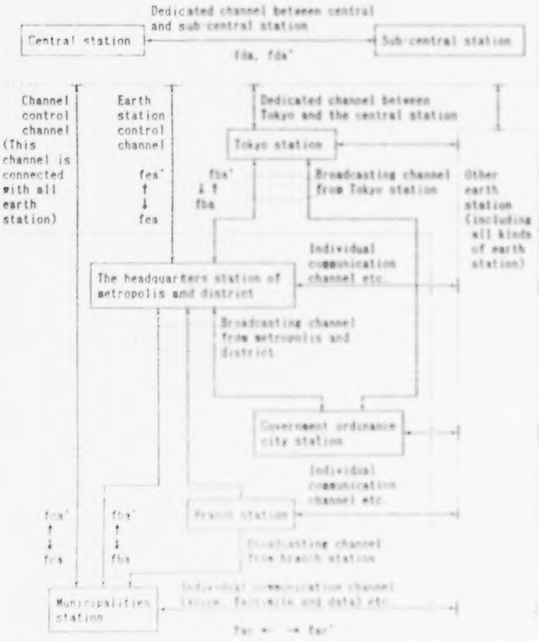
Dedicated channel between central and sub-central station
Central station
Sub-central station
fda, fda'
Channel control channel (This channel is connected with all earth station)
Earth station control channel
fea'
fea
fba'
fba
Dedicated channel between Tokyo and the central station
Tokyo station
Broadcasting channel from Tokyo station
Other earth station (including all kinds of earth station)
Individual communication channel etc.
The headquarters station of metropolis and district
Broadcasting channel from metropolis and district
Government ordinance city station
Individual communication channel etc.
Branch station
fca'
fca
fba'
fba
Broadcasting channel from branch station
Municipalities station
Individual communication channel (Voice, facsimile and data) etc.
fac ← → fac'

Figure 3.1 SATELLITE COMMUNICATIONS NETWORK CHANNELS

f*a',f*b' : Pair transmit frequency of f*a and f*b
When these frequencies are assigned to the station, the frequency can be set at the central station.It is possible to download the channel number "na" or "nb" using the channel which was used to set the f*a or f*b frequency.

f*c,f*c' : Temporarily assigned frequency under control of f*a or f*b for Individual communications etc.
The frequency assignment and corresponding channel number "nc" and "nc'" will be canceled immediately when this frequency is no longer being used. So that transmission and reception of these frequency (f*c or f*c'), without control from the central station, will be prohibited.

3.4 SYSTEM DESIGN

3.4.1 GENERAL

Because of the importance of this network construction, very high availability and reliability are required for this satellite communications network. However,the number of terminal stations at Municipal offices will be come very large and these terminal stations must be very small sized earth stations from the economical point of view. Therefore,considering that most traffic will be between the VSAT stations and the Metropolitan and District stations,the size of the Metropolitan and District stations should be large as much as possible and the system should be designed to meet the above conditions.

3.4.2 CARRIER ASSIGNMENT IN THE TRANSPONDER

The transponders which are used by this network are classified as follows-:

For digital channel transmisson:	two transponders
For analog video transmisson :	one transponder

During initial operation of the network we estimate that the traffic will not be so heavy and therefore only one transponder is needed for digital transmission. The main issues which should be considered in determining the number of digital and analog video transponders are summarized below.

(1) Digital channel
Basically, carrier frequency (f) is
$f=fmt(\text{or } fmr)+0.00005\times nt(\text{or } nr)\text{GHz}$.
$fmt=14.000000$ GHz(uplink)
$fmr=12.250000$ GHz(downlink)
nt (or nr) is an integer ($1\leq nt(\text{or } nr)<10000$).

The Pilot signal frequency is set within the frequency band of the digital channel transponder.

The Pilot signal frequency is set the center of channel spacing and 3 carrier spacing is required as a guard band at both sides of the pilot signal frequency to eliminate interference from the intermodulation.

The frequency bands which are assumed will interfere with an adjacent satellite and the cross polarization performance of the transponder assigned for the downlink channels to the Metropolitan and District stations or for the digital video channel (384 kbps). The interference from these channels is comparatively limited. And the frequency assignment of individual communications channel from the central station these frequency should have the lowest priority. According to the above the priority for frequency assignment by the DAMA system and recognition of dial number must be considered at assigning frequencies.

The digital video channel should be preassigned the same frequency band for the individual communications channel. If the digital video signal is not transmitted in this frequency band,

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the frequency assignment for individual communications channel is executed with a lower priority.
③ The frequency band for transmission of packet type data is pre-assigned according to requirement. The DAMA system does not allows the individual communication channel to use this frequency band.
④ The individual communication channels must be randomly assigned considering items ① through ③.

(2) Analog video transmission
① The carrier frequency for full transponder transmission should be the center frequency of the transponder.
② The carrier frequencies for half transponder transmission should be $f_0 \pm 9.25$MHz, where f_0 is the center frequency of the transponder.

3.4.3 NUMBER OF CHANNELS

(1) Digital channel
When two transponders are used, the number of channels, excluding the control channel, are as follows-:
① Simul command:48 channels/96 frequency bands(maximum)
② Individual communication:650 channels/1300 frequency bands (including channels equivalent to ③ and ④)
③ Packet type data:64 kbps/64 kbps(inbound/outbound)
④ Digital video:384 kbps and/or 64 kbps (pre-assigned)
(2) Analog channel
-Analog video channel:
one frequency (full transponder)
two frequencies (half transponder)

3.4.4 QUALITY AND AVAILABILITY OF CHANNELS

(1) Quality of channel
The quality of the channels are specified in Table 3.3.

Table 3.3 QUALITY OF CHANNEL

Service menu	Quality specification
Individual Communication Channel(including Simul Command) Digital Video Packet Type Data	BER: less than 10^{-5} Specified point: ADPCM decoder input
Analog Video	S/N>45 dB (full) S/N>42 dB (half)

(2) Availability of channel
This system uses a Ku band satellite telecommunications system, and the availability of the channel is mainly determined by degradation of the link due to rainfall. The channel availability is specified by the rainfall. Availability of channel (%) = 100−unavailability of channel (%)
The availability objective is shown in the Table 3.4.

Table 3.4 CHANNEL AVAILABILITY OBJECTIVES

Service menu	Availability objectives
Individual Communication Channel (including Simul command) Packet type data channel Digital video channel	more than 99.95%/year
Analog video channel	more than 99.90%/year

However, in order to relax the specification for the terminal station(VSAT) at Municipal offices the unavailability of digital channel is shared as follows:
Unavailability of the Metro. and Dist. stations:0.01%
Unavailability of VSAT stations :0.04%
And availability objective between VSAT stations must be 99.9%

3.4.5 EXAMPLES OF LINK BUDGET

Typical example of link budget for voice, facsimile and data, are shown in Table 3.5.

Table 3.5 Example 2 of link budget of voice, facsimile and data (32 kbps) channel

Transmit earth station location
Tokyo (municipalities station)
1.8mφ

Receive earth station location
Tokyo (metropolis and district station)
4.5mφ

Uplink unavailability 0.025%
Downlink unavailability 0.007%
Channel availability 99.968%
UPC = 1.1 dB

		Unit	Fine weather	Uplink (Rain)	Downlink (Rain)
U	Earth station transmit power	dBW	-6.1	-5.0	-6.1
P	Earth station transmit feeder loss	dB	0.0		
L	Earth station ANT gain	dBi	45.9		
I	Earth station EIRP	dBW	39.8	40.9	39.8
N	ANT pointing error	dB	0.3		
K	Free space loss	dB	207.0		
	Absorption loss	dB	0.1		
	Rain loss	dB	------	9.2	------
	Satellite receive ANT gain	dBi	39.9		
	Satellite receive power	dBW	-127.7	-135.8	-127.7
	Satellite receive system noise PWR	dBw	-153.0		
	Uplink C/N	dB	25.3	17.2	25.3
D	Satellite EIRP	dBW	19.6	11.4	19.6
O	Output backoff	dB	-33.6	-41.7	-33.6
W	Free space loss	dB	205.9		
N	Absorption loss	dB	0.1		
L	Rain loss	dB	------	------	15.3
I	Noise TEMP degradation by rain	dB	------	------	3.5
N	ANT pointing error	dB	0.4		
K	Earth station ANT gain	dBi	53.2		
	Earth station feeder loss	dB	0.0		
	Earth station receive power	dBW	-133.6	-141.8	-152.4
	Earth STN RX system noise PWR	dBW	-159.0		
	Downlink C/N	dB	25.3	17.2	6.6
T	C/IM	dB	18.0	9.9	18.1
O	Total C/N (including IM)	dB	16.6	8.5	6.2
T	Total C/I	dB	17.5	9.4	17.5
A	Total C/N+I	dB	14.0	5.9	5.9
L	Required C/N+I	dB	5.9		
	Threshold margin	dB	8.1	0.0	0.0

3.5 EARTH STATION

The basic configuration of an earth station, which satisfies the various conditions required by the earth stations operating in the network, are described as follows.
(1) Earth station type
The types and functions of the earth stations which join this network are shown in Table 2.1.
(2) Basic configuration
The basic configuration of typical earth station(VSAT) is shown in Figures 3.2.
(3) The specification which earth station must satisfy are summarized bellow-:
Environmental condition
The design objectives of earth station equipments are as follows-:
① Temperature and relative humidity:

	Meet Spec.	Operation
Indoor equipment Temperature ;	0 to 40°c	-10 to 50°c
Outdoor equipment Temperature:	-10 to 40°c	-20 to 50°c
Humidity :	90% (at 35°c)	

② Wind load:
The station should be capable of operation in wind

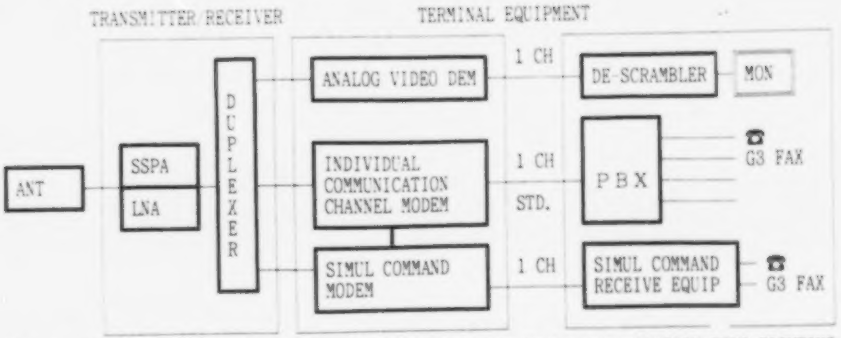

FIGURE 3.2 BASIC CONFIGURATION OF MUNICIPAL STATION, BRANCH OFFICE STATION, FIRE FIGHTING STATION

speeds gusting to more than 30 m/s and capable of surviving, without deformation, in wind speeds gusting to 60 m/s.

③ Resistance against earthquake:
Equipment must be capable of surviving, without damage, against forces of up to 0.5G horizontal acceleration.

④ Resistance against vibration:
Equipment installed at mobile stations must be capable of surviving against vibration.

⑤ Power supply specification:
Power supply fluctuation: Less than nominal voltage ±10%
Frequency change: Less than nominal frequency ±5%

(4) Reliability design

The following items must be also considered to enhance the reliability of the network.

① Configuration of the Central Station
a) Redundant DAMA control equipment
b) Redundant earth station equipment such as the transmitter and the receiver
c) Provision of transmit Uplink Power Control (UPC) to function to provide an adequate rainfall margin
d) Safety design to withstand disaster such as protection against earthquakes and lightning
e) Installation of back up sub-central station
A back up sub-central station, which duplicates the equipment at the central station, must be installed in a separate location with different meteorological conditions because of avoiding the lost network control function of the central station due to a disaster.

② Configuration of the Metropolitan and District Headquarters Station
a) Redundant earth station equipment such as transmitter and receiver etc.
b) Provision of UPC function at the more important stations

③ Configuration of the Municipal Offices Stations
Basic equipment should be redundant. If it is not possible to prepare redundant equipment due to economic reasons or limited space then redundancy should be provided by using the backup terrestrial network.

④ Use of Mobile Earth Stations
The use of mobile earth station should be taken into consideration when fixed earth stations are damaged by unpredictable disasters.

4. CONCLUSION

An expanded telecommunications network will make the world a better and safer place to live in as mentioned in the 1984 Missing Link. Increased investment in telecommunications network is directly related to economic growth. However, a telecommunications network designed for disaster prevention and administrative purposes should have a higher priority. It is recommended that a telecommunications network intended for disaster prevention and administrative purposes should be publicly owned and privately used by local authorities. The choice of technology, i.e., analog or digital, will depend on the current technical trends and cost available at the time the network is being planned. It is reasonably clear that at present the technical trend is towards digital technology.
Both satellite communications and terrestrial microwave communications are used in the LASCOM-NET network because both networks have their own merits. One network should complement the other network. In the same way wired system complement radio systems. The LASCOM-NET network, for disaster prevention and administrative purposes, has been established in Japan. The current utilization of the network is not so large, however, growth can be expected because telecommunications are the basic infrastructure of our lives. Various telecommunication system and methods of providing a disaster-preventive and administrative communication network can be considered by individual operational authorities to suit their own particular needs. We believe that the high reliability and convenience of a satellite network is suited for such applications in many countries. We hope that this paper will still supply useful information when the LASCOM-NET is examined in the year 2004.

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REACHING OUT TO ASEAN EDUCATORS THROUGH TELECOMMUNICATION

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Abstract

This paper discusses ongoing research in distance education training programs for educators in various countries and suggests new project activities through telecommunication delivery systems to reach out to teachers and principals in urban and rural areas throughout Southeast Asia. The goal is to develop an ASEAN educational telecommunications system to provide regionally effective school management and instructional leadership training.

Introduction

"Geography, and to some extent ethnicity and languages, bring communities within ASEAN countries close, but economically there are no outstanding synergies, and until recently political unity has arisen more from discord than from concord," writes Ure in the September, 1993, issue of Pacific Telecommunications Review (p. 4). He stresses the importance of emphasizing national development in furthering economic cooperation and industrial policy coordination. Socio-economic development includes the use of cooperative telecommunication systems to further education among these countries; and, telecommunication reform has become an important element in national agendas among ASEAN countries. For example, the Philippine government recently issued a new national satellite policy that states: "An important telecommunications policy may, if harnessed correctly, contribute significantly to the extension of all manner of communications services to the people of the Philippines, many of whom now do not have access to any or most of these services" (Satellite News, 1993, p. 5).

Public financing of education systems at the elementary, secondary and tertiary level assumes that education will play a major role in maintaining and in developing ASEAN countries to meet changing needs of their people, their economies, their cultures, and their environments. As critical as the needs are among the poor and rapidly growing population, it is not easy to deliver vocational, technical, and professional educational programs to people in Southeast Asia who live in regions with inadequate roads, telephones, facilities, and local infrastructures. How will telecommunications make a difference in the lives of people in Southeast Asia? Willey says:

> Value-added telecommunications means business. It means jobs and an opportunity to participate in the mainstream economy. And it means that participation in the world economy -- brought about through better telecommunications -- can break the ground for other improvements ... better roads, housing, schools, and medical care. Value-added telecommunications enables whole regions to lift themselves up by the bootstraps. (1993, p.112)

The society will have a difficult time finding qualified scientists, technicians, and other professionals to help them cope with modernization. Commitments to further cooperative educational telecommunication systems, particularly for the training of principals and teachers, become crucial for the development of manpower to enhance the development of modern economies in ASEAN countries during the next ten years.

Individual schools need to monitor and to respond to changing employment patterns in their area. Local educational leaders must involve the community in planning, curriculum revisions, outreach efforts, and applied research studies. Often, public intervention can increase participation and reduce dropout rates. For example, officials interviewed in the Philippines, at the Department of Education, Sports and Culture in 1991, suggested that dropout rates are high in rural areas where there are many disadvantaged schools with low achievement rates. They reported recent studies showing correlations between dropout rates and fathers' education and income levels (Swinerton, 1991). If the resources remain inadequate, students will have less chance of receiving a quality education.

One of the major questions is whether telecommunication linkages in education among ASEAN countries help to provide quality education and equity of education for both urban and rural populations. Reduction in the quality gap between urban and rural education remains unsatisfactory throughout Third World countries. ASEAN educational leaders recognize that education is crucial to social, cultural, and political development and to economic advancement. The value placed on education, however, differs among groups of varied interests and needs in life. Schools have been criticized for the low quality of the educational product. While some critics tend to fault the delivery system, others propose to reconsider the content and delivery modes of education. McPhail argues: "as long as rural areas have a reliable telecommunications infrastructure, being rural will not constitute ... the same disadvantage it was when the economy favored producing or manufacturing and distributing of goods for only urban areas (1993, p. 23). He concludes that education, health care, and job opportunities depend upon the will of countries to develop sophisticated telecommunication systems (p. 25).

The development of telecommunication infrastructures is not an easy undertaking in these emerging economies. For example, a study entitled "The Contribution of Distance Education to National Development in Pacific Island Countries" (Yamanaka, Kobayashi, and Ogden, 1993) discusses the difficulty of building the necessary telecommunication infrastructure and up-to-date information technology that will provide students and teachers equitable access to emerging information regardless of their location in the islands. Also, many of those gaining the most from this distance education service tend to emigrate to the rim countries.

Telecommunications and Professional Development

Distance Learning through telecommunications is a viable solution to close the gap between resources and educational needs. A recent study reported:

> The weight of evidence that can be gathered from the literature points overwhelmingly to the conclusion that teaching and studying at a distance, especially that which uses interactive electronic telecommunications media, is effective, when effectiveness is measured by the achievement of learning, by the attitudes of students and teachers, and by cost effectiveness. (Pennsylvania State University, 1990)

There are many examples of successful continuing teacher education programs being done at a distance. Several are presented here. In the United States, in the state of Indiana, instructors from Indiana University have been using teleconferencing and computer-based audiographic technology to reach several rural school corporations. Goals of the program are to help teachers and school personnel cooperatively improve the level of communication at the school site, demonstrate effective teaching practices, and illustrate how classroom, school, and community settings can be altered to give students a wider set of educational opportunities. The program helps teachers to improve their social skills, their ability to assess learning and behavior problems, and their recognition of self management and motivation techniques. It also helps teachers in more mundane tasks such as the structuring of filed practicum activities. Efforts to date show that this instructional approach gives the university and participating rural schools much flexibility in organizing and providing a whole host of training opportunities that are particularly suited to rural communities. Sharing responsibilities for continuing education for educators is enhanced through the use of distance education and autographic technology in Indiana (Knapczyk, et al., 1993).

Another example of using educational television for professional development can be found in the United States, in Kentucky, where there is a state mandate for statewide, performance-based assessment. At the same time, there is a state mandate for each classroom across Kentucky to use research-based instructional practices. Thus, Kentucky Educational Television developed a weekly series of 90-minute seminars using television to reach teachers across the state who otherwise would not have many opportunities for professional development. Their findings showed: "the combination of the various components comprising interactive satellite learning-live presentations by classroom teachers and by university researchers, video taped clips of actual classrooms, interaction through telephone and keypad connections, as well as all the other resources of a professional television station, produces a most potent mode of staff development" (Worley, 1993, p. 73). In all of these distance education programs, faculty development and evaluation are important elements.

In the United States, in the state of Wyoming, the distance learning program has used multiple delivery systems, which include audio teleconferencing, audiographics, and two-way video, in a productive and successful manner for a number of years. The program reports that its success is due to four key elements: "faculty development, class-by-class-feedback forms, midterm feedback sessions, and end-of-course evaluations by both students and faculty" (Shaeffer and Farr, 1993, p. 79).

Since the development of telecommunication systems of delivery may take a number of years to find appropriate financing, public policy support and cooperative agreements between ASEAN countries, it may be useful to start on a more modest scale. One effective system in the United States, in the state of Nebraska, is the audiographics system that helps teachers and pupils in rural areas to learn subjects that would not otherwise be available and to exchange professional communications. The Nebraska system is called the Regional Course Sharing System and provides access in a very inexpensive way to improve instruction for many school districts. The focus is on voice-grade lines called audiographics. Audiographic systems generally consist of two-way audio with still images being transmitted on a second line using a compression technique. There is an "electronic blackboard" that allows transmittal of text and drawings. VCRs, CD-ROMs, scanners, and so forth, can be prepared in advance. Also, a telephone bridge among users allows multiple sites to share information. Leaders of this technology point to success being dependent upon paying attention to the needs of teachers and students trying to cope with learning and interacting with others taking part in technology-enhanced classrooms in Western Nebraska (Wess, 1993).

Many multimedia avenues are available to enhance the effectiveness of telecommunication delivery systems. One example of a promising consortium of Pacific region colleges and universities with their counterparts in the United States is called the Pacific Neighborhood Consortium that 32 institutions in fourteen countries have joined to use computers to share library materials, electronic data bases, and classroom instruction (DeLoughry, 1993). Also, progress is being made in Mexico in increasing academic internetworking so that in the near future many Mexican academic institutions will allow teachers and students across the country to share timely information and new knowledge developments through computer networks (Arreola-Santander, 1993).

SEAMEO INNOTECH

The educational ministers in ASEAN countries have created an organization called SEAMEO INNOTECH (Southeast Asia Ministers of Education Organization, Regional Center for Educational Innovation and Technology). Member countries are Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, and Viet Nam. Encouraged by link agencies within and beyond the Southeast Asian Region to promote globally innovative problem solving in education, SEAMEO INNOTECH hosted an international conference in November, 1991, entitled "Quality Education for All: Innovative Thrusts and Strategies" to share research information, experiences, and insights. From this conference INNOTECH has recognized the need to search for effective ways for delivering education and producing the desired person in each learner through the use of educational technologies, integrative distance education, and cooperative learning. INNOTECH has also recognized the need to link formal and nonformal education toward an integrated learning system.

On a regular basis this regional center works with educators in all ASEAN countries to further their educational missions with a major priority in the 1990s to retrain and upgrade the knowledge and skills of principals and teachers at the elementary, secondary, and postsecondary levels. INNOTECH, in fact, has identified four major objectives for priority action in the 1990s:

1. To conduct studies and offer training programs on how cultural factors affect educational quality and equity.

2. To examine effective indicators of quality elementary, secondary, and post secondary education among various groups with varying needs in life in both urban and rural areas, and to provide training suggested by these indicators to educators.

3. To study the role of schooling in the enhancement of lifelong education and to provide training programs for educators to enhance lifelong education program leadership.

4. To examine effective school management and instructional leadership and to provide training programs for educational staffs.

To accomplish these four objectives, INNOTECH recognizes the need for developmental design of innovative delivery systems to reach out to these educators in ASEAN countries in urban and rural locations. Examples of multi media instructional efforts to date include the following projects:

1. Videos are being developed as part of Project LEAD. Project Learning for Effective Administrator Development is funded by the Canadian International Development Agency (CIDA) through SEAMEO INNOTECH's institutional linkage with the Saskatchewan Institute of Applied Science and Technology. Its goal is to develop a non-conventional delivery system of in-service training for the improvement of the instructional leadership skills and competencies of school heads throughout Southeast Asia. One video tape is available and six more are under development.

2. Working with Learn Tech through the Institute for International Research in Washington, DC, SEAMEO INNOTECH is working on two teacher training modules that employ the use of video as a means of assisting teachers in acquiring effective teaching skills and adopting exemplary teaching practices.

3. Six interactive computer conferences between Southeast Asian and North American educators have been held to exchange views on distance education, school based evaluation, learning styles, and

cultural differences. The Saskatchewan Institute of Applied Science and Technology provided the network linkages for the information sharing.

4. Village cooperative and community development projects in selected villages in the Philippines have trained local officials who can use computer programs for community development under an INNOTECH program called Project Computers for Rural Education that was funded by IBM Philippines, Inc. (Personal interviews at INNOTECH, November, 1993.)

Generally, however, ASEAN countries have relied on sending small groups of people to the INNOTECH training facilities in the Philippines to accomplish their educational objectives. For the most part, these trainees return to their home countries to serve as trainers in various regions of their nation. This training system cannot handle the growing need for teacher retraining in these countries to meet quality standards and equity demands in a rapidly changing socioeconomic environment. Telecommunications is one avenue of opportunity that needs developmental initiatives to help to cope with these ongoing changes in education at the elementary and secondary schools in the Third World.

Educational Telecommunication System for ASEAN Educators

Over the past ten years, resources have been inadequate in many of the countries of the Pacific Rim to advance education at all levels. A 1990 UNESCO report to a regional conference in Thailand on the theme "education for all" emphasizes the wide gap in the region between the large number of needs to further education and the resources available to advance education (Tasker, 1990, p. 20). Closing this gap may well depend in large measure on ASEAN telecommunication programs designed by educators in ASEAN countries, which offer diverse learning experiences that take into account the needs and context of learners in ASEAN countries while maintaining established academic standards. De la Sotta emphasizes the importance of using telecommunications in education and training as rational ways of achieving integration in a developing nation's economy that offers people "a best life standard (health, primary provision, etc.) without losing cultural and ecological values" (1993, p. 118).

The multimedia delivery modes of professional training for teachers and principals (such as computers, telephone lines, satellites, faxes, and so forth) should be selected to deliver instruction that is compatible with the objectives of the program and appropriately provides these learning experiences in a timely way. Also, the assessment of these distance learning programs to train teachers and principals should be based on the achievement of comprehensive and specific learning outcomes that are compatible with the receiving educational environment. Overall administration of the telecommunications training program should involve educators from all participating ASEAN countries on a continuing, systematic basis to assure standards and quality and to stimulate program improvement such as provided by SEAMEO INNOTECH.

Telecommunications emerges as a viable option to reach out across these ASEAN nations from INNOTECH's headquarters in the Philippines because of a digital compression technology that makes satellite-delivered education more feasible due to the huge change in available capacity and the sharp drop in per program costs. In the United States, some studies show that this new technology can reduce the cost of distance learning by up to 85 percent.

As administrators' responsibilities expand, complexity and information overload become more evident. For example, how can school principals under pressure reflect on their actions, learn new insights, and adapt future behaviors? At the secondary level, one of the answers is to provide additional training either in person or by telecommunications to the building principal who is the chief executive officer, supervisor, and decision-maker. In many ASEAN countries, his or her attitudes and procedures can determine to a large extent the school's plans to make the school and the district more effective. To carry out the planning involved at the building level, the leadership of the principal is the key to success. This person, along with other professionals at the elementary and secondary levels, needs to demonstrate and model the way. Decentralized leadership requires principals, superintendents, college officials, and local community leaders to take educational initiatives to meet particular social, cultural, and economic needs of provinces and regions. INNOTECH needs a telecommunications system to provide training to more educational leaders in ASEAN countries.

If schools in ASEAN countries can expand their teacher training programs without much added cost for training personnel, facilities, and materials, they will be able to offer courses and programs reaching both urban and rural educators that are of the same quality, but courses that can be tailor-made for urban and rural audiences and that respond to differences in regional cultures. One of the main advantages of multimedia distance learning is that many school districts have a difficult time in keeping up with changing educational processes, teaching techniques, and content development in various fields. If countries are pursuing national development strategies requiring new initiatives to train or to retrain the workforce, distance learning through telecommunication networks can be of great value (Lambert, 1993).

There is no question that the high cost of switching to multimedia modes of delivering distance education will necessitate shared equipment and cooperative partnerships with business, industry, government, and education. If INNOTECH can provide the leadership in developing cooperative infrastructures among educators in participating ASEAN countries, it may reduce the costs associated with these delivery modes. Maule emphasizes: "High capacity, wide-area communication networks are expensive and necessitate shared and common services. Educators must take advantage of cooperative networks and public information services to initiate partnerships with industry and government" (1993, p. 200).

The following project format would serve as a beginning for ASEAN educational leaders and INNOTECH staff involved in professional development of teachers and principals to work together over the next several years to develop a viable telecommunications system for serving the needs of participating ASEAN countries. Included in the early phases of this project would be a one month internship in the United States for those involved in this project.

Telecommunication Project Recommendation

INNOTECH needs international educational partners to assist in planning and conducting developmental research on innovative delivery systems. The objective would be to identify one or more educational technology programs or telecommunication delivery system components that need enhancement and implement changes in communication linkages to assist INNOTECH and participating ASEAN educators to:

1. establish improved telecommunication technologies that enhance the effectiveness of the delivery system;
2. use telecommunication technologies to reach teachers and principals in seven Southeast Asia countries and to help them upgrade their skills and knowledge at the elementary and secondary levels;
3. encourage involvement of experts from many nations in project activities;
4. create a model for cooperative educational exchanges for use in other countries;
5. enhance cultural understanding between the United States and Southeast Asia.

In the United States distance education, educational technology, communication theory and practice, and adult education are undergoing rapid integration in technological, interdisciplinary, and international modes of communication. Among the leaders in distance education and communication theory and practice are the National Center for Communication Studies and GW Television of The George Washington University (GWU). Among the leaders in adult education and quality practices for distance learning is The Center for Adult Learning and Educational Credentials of the American Council on Education (ACE). GWU and ACE are natural partners in this program to reach out to facilitate project activities among participating ASEAN countries through the leadership of SEAMEO INNOTECH.

PROJECT FORMAT:

I. PHASE I: PROBLEM IDENTIFICATION

A. Fact Finding Assignments of Participants in Home Country Prior to Internship (Three Months)

1. Participant Orientation and Information Training
2. Identify Telecommunication Technologies and Distribution Capacities Existing within Each Country
3. Identify Related Corporate and Government Programs for Possible Operational and Financial Support
4. Prepare Documentation of Possible Telecommunication Technologies in Each Country Using Digital Capabilities through Combining Audio, Video, and Data Systems in an Interactive Multimedia Environment
5. Gather Information on Educational Credentialing Practices for Formal and Nonformal Education Programs for Adults Involved in Telecommunication Delivery Systems

II. PHASE II: INTERNSHIPS

A. Information Exchange Workshop on Philosophy and Practices of Communication, Adult Education, Distance Education, and Educational Technology (Washington, DC, First Week of Fourth Month)

1. Explore Communication Styles, Modes, and Practices
2. Review International Adult Education Principles and Practices
3. Share Fact Finding by All Participants on Telecommunication Technology, Distribution Capacities, and Educational Credentialing of Distance Learning
4. Visit and Receive Orientation at Innovative Centers of

Communication, Educational Technology, and Interactive Learning

5. Design and Understand Heuristic Model for Accomplishing "Hands On" Internships in the Field

B. "Hands On" Internships at American Colleges and Universities (Second and Third Weeks of Fourth Month)

1. Work Closely with Educational Technologists and Distance Educators
2. Learn How to Apply Interactive Educational Technology in Telecommunications, Computers, Digital Telephones, Faxes, etc.
3. Review Educational Programs Conducted in Distance Education Format
4. Participate in Social and Cultural Activities with American Families

C. Information Sharing Workshop-All Participants (Fourth Week of Fourth Month)

1. Exchange Information on Educational Technologies and Distance Education Gained from Internships
2. Share Information on American Social and Cultural Experiences
3. Suggest Best Approaches for Applications
4. Discuss Funding Opportunities with Government, Foundation, and Corporate Sponsors
5. Recommend Next Steps to Develop Plans, Programs, and Technologies in Home Country for Learners and in Cooperation with SEAMEO INNOTECH
6. Visit with American Families and Tour Washington Sites and Museums

After the completion of the internships in the United States, evaluation of the project will occur on several levels. Participants are expected to return home to share findings and to identify next steps in their own country and in cooperation with INNOTECH in the advancement of educational technology and distance education and prepare an action plan for implementation. A questionnaire will be administered to interns after six months to indicate the impact of the internship experience. INNOTECH will identify interests in implementing project goals individually and cooperatively among ASEAN countries. GWU and ACE will work with INNOTECH to identify ways that U.S. colleges and universities can contribute to the design, development, and implementation of project goals over the next five to ten years. Part of the evaluation will be to determine the multiplier effect of increased knowledge and use of educational technology and distance education within and among countries as an integral part of the training of teachers at the elementary, secondary, and postsecondary levels in the overall process to improve the quality of, and access to, education in both rural and urban areas throughout Southeast Asia.

Conclusion

These collaborative linkages between the United States and Southeast Asia must continue into the twenty-first century to meet the challenges of a global society recycling itself into information societies. For U.S. participants, this initial pilot project might serve as a basis for beginning a long-term relationship in sharing information with our Southeast Asian partners on adult education, multimedia distance education, educational technology, and communication theory and practices. As we conduct research studies, offer courses, and serve as resource persons on international communication systems and for educational innovation and change, partnerships like these help to put together building blocks that allow all of us to tie theory and practice together and to overcome cultural differences in the pursuit of educational excellence.

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A Concept For The Provision of Distance Education By Satellite For The South Pacific

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1. ABSTRACT

This paper reviews a study which has been undertaken to determine the feasibility of establishing a telecommunications network in the South Pacific for distance education. There is an urgent need to provide distance education to the South Pacific island countries and specifically their institutions (e.g. the multinational University of the South Pacific (USP), the University of Papua New Guinea (UPNG) and the College of Distance Education (CODE) in Papua New Guinea among others). These institutions are seeking an effective means to improve communications among their campuses and centres which are widely dispersed and presently not adequately served.

2. INTRODUCTION

The Commonwealth of Learning (COL), which has its headquarters in Vancouver, Canada has been mandated to assist Commonwealth governments, and certain of their institutions, with the development of appropriate systems of distance education. A major focus is establishing a facilitating regional telecommunications network in the South Pacific. Fundamental to the concept is the possibility of establishing a centrally-managed shared network for use by national or regional institutions.

Two aspects of such a shared network are paramount. On the one hand, cooperating member organizations would call on the network for their communications needs, either in relation to inter-institutional links or for the delivery of distance education programs to their clients. On the other, for network management and operation purposes, an intermediary or broker agency would have responsibility for making the required capacity available, as defined by the users.

This concept is timely. There is an increased awareness and motivation in some countries for the need to enhance "village services". The provision of effective distance education is a key element. The recognition of the importance of distance education it is hoped will result in governments facilitating the implementation of a network through appropriate regulatory and funding policies.

The areas covered in this paper are as follows:

(i) Identification and assessment of the telecommunications requirements of the major providers of distance education and training within the South Pacific region.

(ii) Review of the telecommunications networks and services currently available within the region, and those expected to be available within 2-3 years, and assessment of their suitability and cost-effectiveness for distance education and training needs.

(iii) Identification of a cost-effective technical approach, based on a multi-purpose multi-user regional network, to meet current and future telecommunications needs of the providers of distance education and training in this region.

3. REQUIREMENTS

The telecommunications requirements fall into two main categories: (1) the services to be provided and (2) the institutions and their constituents to be served.

As to services first and foremost is a need for audioconferencing. The second requirement is for data transfer which could include file transfer and E-Mail. A mesh network for audioconferencing is preferred to allow direct interactive communications among participants. A star arrangement which involves relaying via a central node is acceptable for data transfer which is not time sensitive and in fact may be scheduled for transmission in off-hours. The primary applications are administration and tutoring. Course lecturing is not viewed as a requirement given the present method of distance education which revolves about a print-based learning system. Enhancements such as audiographic support to audioconferencing, videoconferencing, video distribution of lectures are seen as desirable but not mandatory core features. Given the experience of certain institutions with faulty local terrestrial connections, a common requirement is a reliable system that encourages use of the network by the educators. With most services required for blocks of time typically 1 hour for audioconferencing, services can be arranged on a scheduled basis. Furthermore, because audioconferences are structured a half duplex communications system that uses in the first instance a verbal protocol controlled by the session's coordinator is acceptable provided an electronic mechanism is provided to avoid any one verbose participant from overextending his use of the channel. Depending on computer-to-computer data protocols, half or full duplex circuits may be required.

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With respect to the institutions to be served, the primary set includes those in the South Pacific area (Figure 1) namely USP, UPNG and CODE. During the course of the study the concept of a number of evolving networks was developed. The primary set of institutions was expanded to include a number in Brunei, New Zealand, Malaysia, Singapore. This set encompasses the Basic Network (BNet) which has been the focus of the study (Figure 2). The BNet provides the audioconferencing and data transfer services for these institutions and would allow intra- and inter-institutional communications. Intra-institutional communications would be between main campuses and centres and not outlying sites which have a very small number of students. An Enhanced Network (ENet) would at some time in the future be developed and provide enhanced services including for example videoconferencing and television distribution among the headquarters of major institutions in the Southwest Pacific and the Pacific Rim. The Primary Network (PNet) would also be a future system that would link institutions to locations having a small number of students for which audioconferencing only is required. BNet sites are expected to participate eventually in both the ENet and the PNet; however, ENet and PNet sites would not interact directly.

4. AVAILABLE NETWORKS AND FACILITIES

While fibre cables are available in the Pacific they generally connect few of the sites of interest (Figure 3). Satellite communications provides wide area coverage, allows for rapid deployment thereby providing a quick and reliable means of extending and enhancing education for distant centres and remote communities. While the most suitable technology is satellite communications, this does not preclude fibre for selected use among those sites having ready access to fibre connection points.

The networks and facilities in the region of interest vary somewhat depending on the country or institutional geographic extent. Table 1 depicts the deployment of earth stations operating with the Intelsat satellite system.

For USP most of the current inter-centre links are satellite-based using space segment provided by Cable & Wireless (C&W) on an interim basis on Intelsat V. The earth stations are those belonging to each country's international carrier; these have been constructed to meet international telephony needs of the country and are large Intelsat A or B stations to which have been added the channel units needed for the institution's carrier. In some cases a smaller Intelsat D station is used. In most cases the links between the earth stations in each country and the institutions are terrestrial backhauls provided by the local telco. In some cases these backhauls have had reliability problems and also have been costly. HF communications is also used as a supplementary means to connect sites without satellite earth stations. In the Solomon Islands a domestic system is used for telecommunications as well as internal distance education. This system uses the Intelsat satellite and facilities provided by C&W.

In the near term (1-3 years) while numerous satellites are planned for the Asia/Pacific region, the ones that would cover the Southwest Pacific and include links to Australia, Brunei, Malaysia and New Zealand include the Intelsat series and Panamsat 2. Only the Intelsat satellites provide full single beam Southwest Pacific and Pacific Rim coverage, as well as North America (the latter would be desirable for linking with COL's headquarters and larger institutions in North America). The current Intelsat V satellites will be replaced by the more powerful Intelsat VII satellites in this time frame.

The PACT network provided under contract by AOTC (Australia) to the Pacific Forum countries is a complete telecommunications network that has used the Intelsat V satellite and the earth stations belonging to the international carriers in each participating country. AOTC has been developing a proposal for USP to provide a USPNet by means of PACT.

It is our opinion that the proposal would require further development before it would satisfactorily address the service requirements of the institutions.

5. PROPOSED SOLUTION

The proposed network is based on a satellite communications backbone. The key issues associated with this network are as follows.

(i) **Features.** The network architecture is shown in Figure 4. Services will include audioconferencing, file transfer, E-mail with an optional capability for facsimile. The allocation of resources from a Network Control Centre is based on prior scheduling. Each earth station will be able to simultaneously operate over a half duplex traffic channel and a signalling channel. The traffic channel is used for user information while the signalling channel is used for network coordination involving the network controller and the session coordinators as well as messages between conference participants.The voice quality is based on the 32 kbit/s international standard for toll quality voice. Improvements in voice coding technology that will maintain this quality but only require a 16 kbit/s rate are imminent; this rate reduction can be used to double capacity or reduce the size of the earth stations needed. Satellite earth stations having 3.8 m antennas would support full mesh communications. With an initial complement of say 4 traffic channels full duplex sessions could be scheduled where computer-to-computer off-hours file transfers require such links.

(ii) **Satellite Options.** The baseline configuration assumes use of an Intelsat VII satellite because this satellite will be available starting in 1993, it provides full coverage through its global beam of the Southwest Pacific and the Pacific Rim and many of the carriers in the region are Intelsat signatories. Potential satellite systems using spot beams would provide more power and hence smaller earth stations; however, full coverage of the Basic Network (BNet) would be compromised. Use of an alternative satellite such as Panamsat's PAS 2 would also provide high power but with reduced coverage. In addition, new arrangements would be necessary in all countries to allow for a second competitive international satellite system. Other satellite systems are not precluded and in fact may be economically more advantageous. However, there are extra political and regulatory hurdles relative to an Intelsat solution. A longer term benefit of the presence of a number of competing satellites will be a much greater competitive environment which should result in lower tariffs.

(iii) **Network Configuration.** The baseline assumes a satellite network with 3.8 m earth stations located at user sites. This approach provides a common solution for all sites thereby providing an economy of scale advantage in earth station procurement. Also it minimizes the number of transmission paths and hence the number of potential failures. Customized solutions are still possible on a site by site basis. Such solutions could include the use of existing earth stations and terrestrial (cable, microwave) backhauls. However, it is possible that existing carrier earth stations may have to be upgraded with a second antenna and IF/RF subsystem if the network is required to operate on a satellite located at orbital slots other than 174 degrees East (as is now generally used). In this case there may not be any economic advantage.

(iv) **Earth Station Ownership.** Earth stations could be owned by the individual institutions, or leased either from a third party or as part of a service-provider service arrangement. Given the current state of the art earth stations are now designed to include self test features together with remote monitoring capabilities. In addition, they are now highly modularized with a small number of modules. These aspects mean that troubleshooting is usually straightforward and repairs are usually based on field replacement of modules by relatively unskilled personnel. Failed modules are then sent to a regional repair depot. This approach assumes the availability of on site spares. Hence, a very modest maintenance staff is needed. Given the availability of repair facilities operated by the carriers in the region they should be considered for service contracts. As to earth station ownership versus lease, this is governed by both economic and regulatory issues. It may be economically more attractive in terms of capital cost alone for institutions to own the earth stations. However, it may be politically easier to have a service provider arrange earth station procurement, licensing, operation and maintenance.

(v) **Network Control.** The cost-effective use of a network requires tailoring the capacity to the traffic as well as the grade of service expected by the user. An over-riding issue in the region has been the cost of the service. Totally unrestricted availability of and access to communications links requires dedicated facilities for which there is a price to be paid. The underlying basis of the COL network is the bulk purchase of capacity which is then allocated according to the needs of the participating institutions. There are two issues here. The first is whether the capacity pool is adequate. The second relates to how and by whom capacity is assigned. The former is really an issue of demand - the greater the demand the more capacity can be leased. The second issue is more sensitive because it concerns jurisdictional control. The proposed network is based on a central hub which schedules useage according to requests some time prior to the required session. The hub also serves to monitor the health of the network and to monitor the earth stations. It also determines useage by institution for billing purposes. There is really a need for only one reliable hub. Should a particular institution be adamant in having its own network the proposed design is certainly applicable. However, a more cost-effective approach is one based on a single hub shared by all the institutions. Political sensitivities aside it would be attractive to locate the hub where its continuous operation can be assured and where it can be reliably maintained given its central role to network operation. The distinct impression from a field trip to the Southwest Pacific was a need for a politically acceptable approach. It would appear that possible hub operators could include the Pacific Forum, a service provider in the area such as AOTC or C&W, or COL itself. AOTC already operates the PACT system from a hub in Sydney under contract to the Pacific Forum and could provide a distance education network as an enhancement to PACT. C&W could similarly establish such a network. Finally, given the Intelsat coverage COL could probably with Teleglobe consider establishing a hub in Vancouver.

(vi) **PACT Network.** AOTC have been developing a proposal to USP for a distance education satellite network using AOTC's DAMA-Net facilities (these are also used to provide the PACT service). The similarities between AOTC's network and that proposed here indicates that continued discussions should be pursued to ascertain the viability of establishing a system that encompasses the proposed system. AOTC are planning to offer earth stations intended for installation on customer premises to the island countries and their system incorporates a DAMA system so there exists a "platform" for establishing a COL network.

(vii) **Costs.** Capital and operating costs will vary depending upon the availability of existing equipment, the extent of new development required to fulfill the service objectives and technical proposal described herein, the arrangements made with respect to earth station procurement/lease, the use of backhaul facilities, the actual space segment costs, the degree to which institutional needs and government policies can result in more favourable rates, duties, taxes, shipping and installation costs. Many of these costs need to be determined. However, as a guide the expected capital cost of an initial system would be on the order of USD$3.0 million. This system would include the satellite earth station transmission equipment associated with one NCC, 6 convenor sites and 14 remote sites. The annual operating cost covering 4-32 kbps half duplex voice channels and 1-9.6 kbps signalling channel, and maintenance would be approximately $350,000. Note that the space segment charges that have been included are coarse estimates and can only be made firm through negotiations with the carriers.

6. RECOMMENDATIONS

It is recommended that:

a. The network configuration of the BNet as outlined in this study be confirmed with the institutions involved. This will provide the necessary information on which to base further investigation and provide an indication of the quantity of equipment that is necessary.

b. An assessment of the quantitative requirements for the various services be made. This can then be translated into voice and data channel requirements and the necessary signalling overhead added.

c. A detailed costing of the various network options based on the preliminary cost estimates contained in this report be carried out in conjunction with the carriers and other service and equipment providers. This will provide a firm basis on which to construct a capital and operations budget.

d. Discussions begin with interested parties including the Pacific Forum and the ministers of education and communications in each country to resolve political and regulatory issues. There was a strong recommendation made during the field trip that such issues be addressed prior to committing large sums to the procurement of facilities.

e. A network technical specification be prepared. This will provide a sound technical foundation for planning the network and its expansion. The specification will be used as part of a procurement request for proposal.

7. SUMMARY

This paper has summarized the telecommunications requirements of the major providers of distance education in the South Pacific region, reviewed the telecommunications networks and services presently available and expected in the next 2-3 years, and presented a technical approach to solving the needs of the community of interest. It is hoped that this material will serve as basis for reaching concensus among the parties in proceeding towards implementing a network that is vital to their distance education needs in a timely manner.

ACKNOWLEDGEMENT

This paper is based on work performed for the Commonwealth of Learning under contract 920827-01/01A. The author wishes to thank Messrs. R. Simpson and P. McMechan of COL for their support and advice.

Table 1 Intelsat Earth Stations in the Core Region of Interest

Country	Earth Stations		
	Type	Number	Location
1. Papau New Guinea	- Standard, A, B - Standard F1	1 ea 1 ea	Port Moresby Lae
2. Solomon Islands	- Standard D	1	Honiara
3. Vanuatu	- Standard A	1	Port Vila
4. Kiribati	- Standard B - Standard D1	2 1	Bairiki, Christmas Island London
5. Nauru	- Standard B - Standard F3	1 1	
6. Tuvalu	- Standard D1	1	Vaiaku
7. Tokelau Islands			
8. Western Samoa	- Standard B	1	Afiamalu
9. Tonga	- Standard B	1	Nuku' Alofa
10. Niue	- Standard D1	1	Kaimiti
11. Cook Islands	- Standard B Standard D1	1 4	Avarua Atiu, Manihiki, Mauke
12. Fiji	- Standard A	1	Suva
13 Marshall Islands	- Standard B	2	Ebeye, Majuro

NOTES:

1. Kiribati earth station at Christmas Island owned by TRW.
2. Intelsat earth station at:
    i) Lae pointed at satellite at 177 degrees East.
    ii) Nauru (Standard F3) pointed at satellite at 180 degrees East.

All others pointed at satellite at 174 degrees East.

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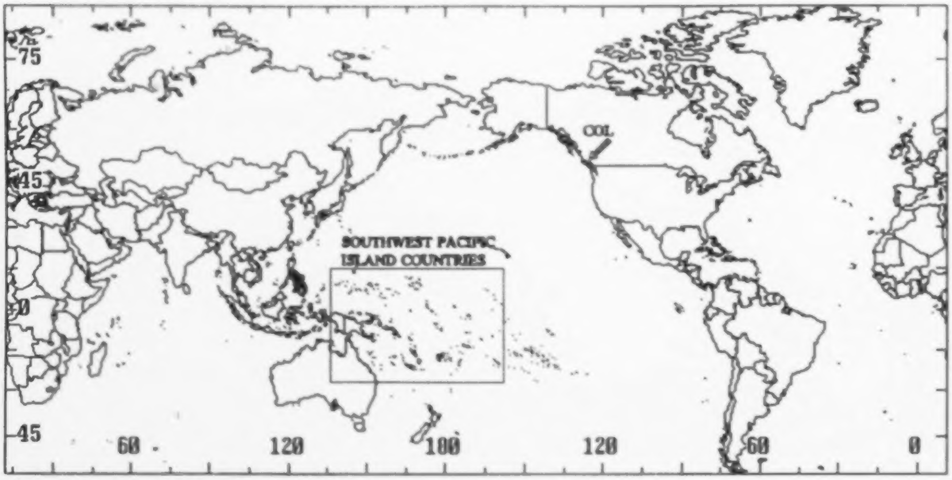
75
45
0
-45
60
120
180
120
60
0
SOUTHWEST PACIFIC ISLAND COUNTRIES
COL

Figure 1 CORE REGION OF INTEREST

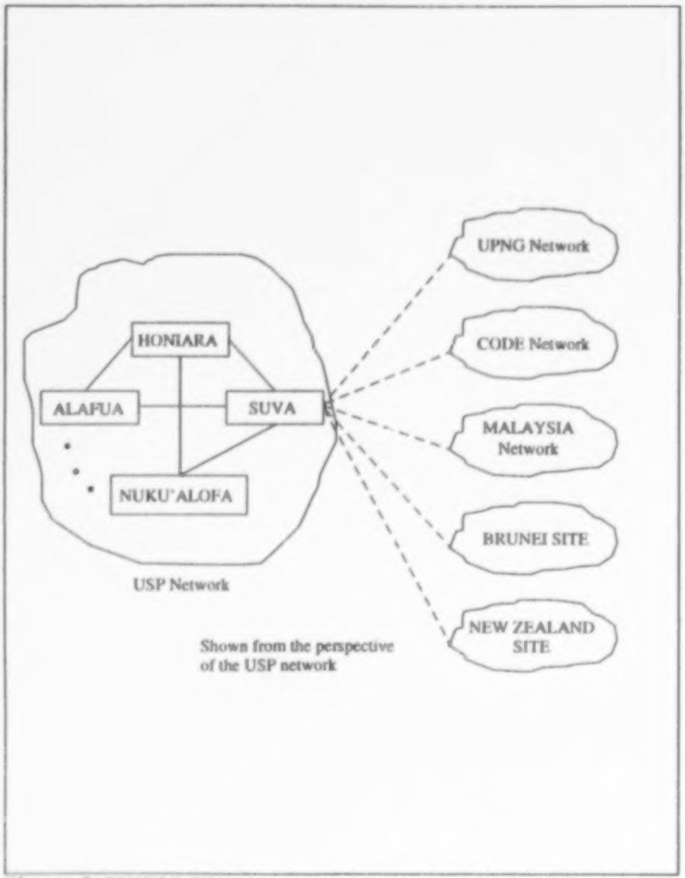
HONIARA
ALAFUA
SUVA
NUKU'ALOFA
USP Network
UPNG Network
CODE Network
MALAYSIA Network
BRUNEI SITE
NEW ZEALAND SITE
Shown from the perspective of the USP network

Figure 2 EXAMPLE BNet

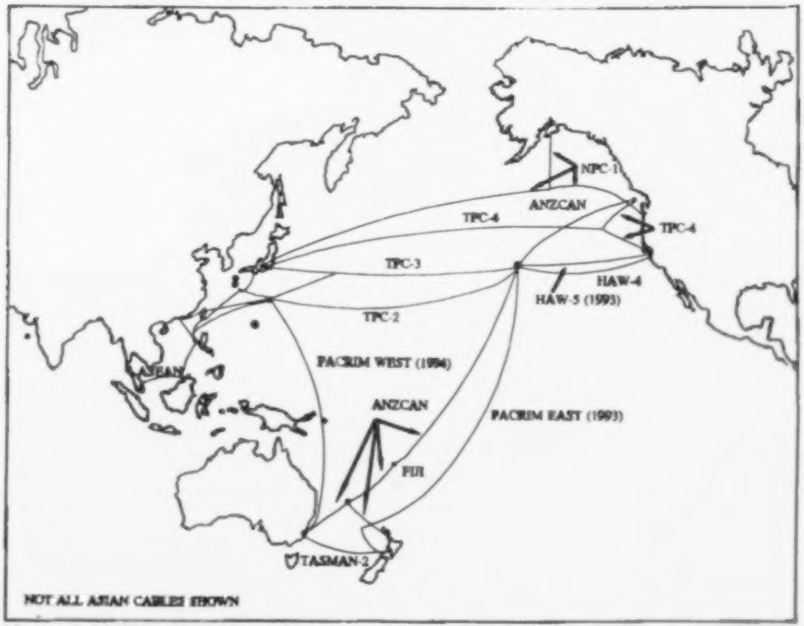
NPC-1
ANZCAN
TPC-4
TPC-4
TPC-3
HAW-4
HAW-5 (1993)
TPC-2
ASEAN
PACRIM WEST (1994)
ANZCAN
PACRIM EAST (1993)
FIJI
TASMAN-2
NOT ALL ASIAN CABLES SHOWN

Figure 3 PACIFIC OCEAN CABLES

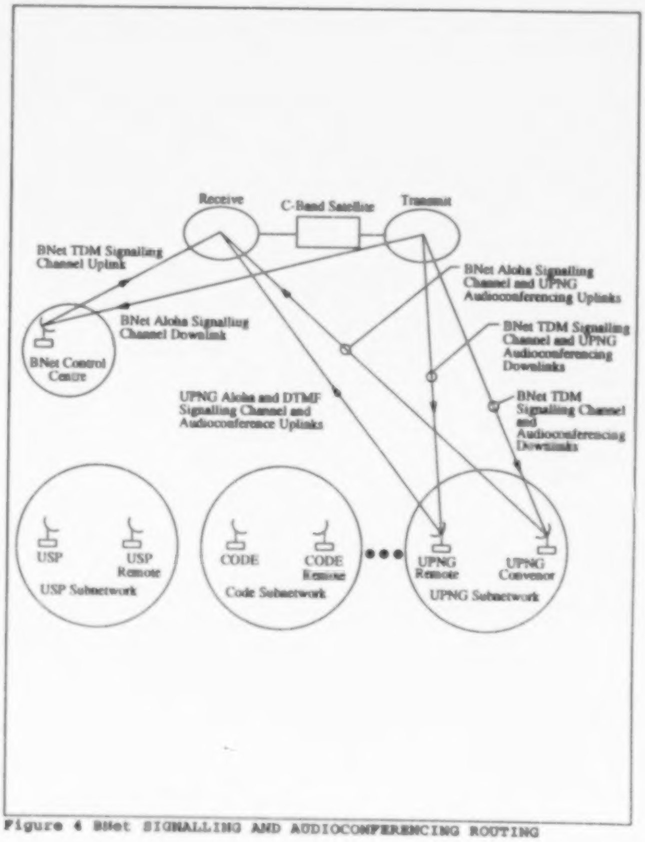
Receive
C-Band Satellite
Transmit
BNet TDM Signaling Channel Uplink
BNet Aloha Signalling Channel and UPNG Audioconferencing Uplinks
BNet Aloha Signalling Channel Downlink
BNet TDM Signalling Channel and UPNG Audioconferencing Downlinks
BNet Control Centre
UPNG Aloha and DTMF Signalling Channel and Audioconference Uplinks
BNet TDM Signalling Channel and Audioconferencing Downlinks
USP
USP Remote
USP Subnetwork
CODE
CODE Remote
Code Subnetwork
UPNG Remote
UPNG Convenor
UPNG Subnetwork

Figure 4 BNet SIGNALLING AND AUDIOCONFERENCING ROUTING

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Educational Alternatives for Developing Economies:

The Global Learning Network (GLN)

by

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1. ABSTRACT

Combining the stated goals of the UN and the Maitland Report makes it reasonable to assume that the technological, communication, and financial infrastructure required for a Global Learning Network (GLN) easily accessible to at least 70 percent of the current more than 5 billion citizens of planet Earth will be basically in place by the beginning of the next millennium. Consequently, it is now appropriate to focus on desired educational applications. This 21st Century concentration on the priority needs of the Developing Economies is vital so that **the core process of HyperLearning (HL)** drives the technological infrastructure and financial institutions instead of vice versa.

2. INTRODUCTION AND METHODOLOGY

What is the GLN as defined in this paper? The Global Learning Network (GLN) is the sum total of all **digital** technologies that make it possible to create and disseminate knowledge. It is the total human and computing machines network accessible via the ongoing fusion, some would say implosion, of intelligent tools such as computers, telecom devices, and so on. Presently, most digital information is carried by electrons; however, photons of light will increasingly become the digital workhorses of the HL revolution.

"But these machines have changed, and so have their roles. No longer the exclusive province of a technical priesthood, they are just beginning to fulfill their destined purpose as information organizers in an age of information glut. Their value lies in their ability to help us organize the overwhelming mass of raw industrial, economic, demographic, and scientific data society now generates into forms that can be used to solve problems -- in other words, to turn *information* into *knowledge*. And nowhere is the need for knowledge greater than in the drive to create a sustainable global economy." (20)

The next evolutionary step *beyond knowledge* is *wisdom*. If information is the thread and knowledge the pattern, then wisdom is the ability of pattern-seekers to discern the best templates/blueprints for our collective future.

The methodology of this paper is content analysis of a wide variety of books, periodicals, and papers combined with first-hand experiences in implementing and utilizing these smart tools in an HL environment.

Based on the preliminary experience of HI, Inc./FYI (The first and still the only **state-wide**, public electronic gateway in NAFTA.) and JAIMS, the imminent Digital Universe "in a shoebox" presents a tremendous opportunity for the Developing World to take a quantum leap over the Industrial Age and start "swimming" directly into the Knowledge Society. Some countries such as Singapore and Hong Kong appear to already be following this leapfrog development strategy.

The Economics of a Degree in the USA

"A college degree can dramatically increase an individual's income earning potential. According to government figures an individual with a bachelor's degree earns approximately $300,000 more in a lifetime than a high school graduate, a master's degree is worth nearly $500,000 more than a high school diploma and a doctorate approximately $800,000 more, and it is now possible to earn these degrees without formal, traditional classroom attendance." Guide to Alternative Education (1993)

But such college credentials are merely gold-plated lifejackets according to Dr. Lewis Perelman (13b).

The examples of Japan, Taiwan, Korea, and others have demonstrated the value of mass education and lifelong human resource development. So for personal and social development reasons the so-called Developing World has a large pent up and growing demand for "sheepskin" education which can not be satisfied by traditional educational delivery mechanisms. This educational chasm is a big part of the problem that divides the world into the information haves and have-nots.

In an attempt to meet this huge educational challenge, a logical, extreme question to ponder is: "If all of the world's accumulated wisdom were instantaneously available to any person in the world, anywhere, anytime, why would we continue to need 'bricks and mortar' schools as we've traditionally known them?" Obviously, we're not quite at this stage yet, but many people will be approaching this era of information abundance in the near future which has tremendous implications for the future face of education, training, and the entire socio-economic-political system (1) in which we live.

3. LITERATURE REVIEW, HISTORICAL CONTEXT, AND KEY DEFINITIONS

Fortunately, Dr. Perelman has already prepared a firm, twenty-year, research-based foundation for our inquiry in his new book (13a), School's Out: Hyperlearning, the New Technology, and the End of Education. Dr. Perelman has suggested a micro voucher proposal for financing the massive investments required in hardware and software for implementing these pioneering curriculum endeavors. In these unique Virtual Collaborative Learning Communities (VCLCs) each student-participant receives personalized, individualized attention, and each hyperlearner can proceed at his or her own pace. The system includes E- and V-mail for convenient interaction with other students, teachers, and administrators.

"On a smaller scale, the computer revolution is changing patterns of personal learning, as well as of institutional research. Popular programs like SimEarth allow computer users to simulate the growth and impacts of entire civilizations. EnviroAccount allows computer users to assess their environmental impacts--and track how changes in lifestyle can change them. And the Global Lab, an international project of the Boston-based Technical Education Research Center, has helped schoolchildren learn about environmental problems by monitoring them themselves. Students use computers to collect data and examine their results, and to share their results--via computer networks--with children in other countries." (20)

"We must see ourselves not only as transmitters of knowledge but as **facilitators of learning (emphasis mine)**. Students, in turn, must reconsider their perception of education. They must see education not only as learning what others think but as thinking to learn for themselves. This means that the classroom must change from a setting in which the professor only lectures and the students only listen, to a setting in which a supportive atmosphere for active learning is created, one in which students engage in learning activities. It is in this setting that students become true learners--taking knowledge and making connections with one's world." (signed Deans of Colleges of Arts and Humanities, Social Sciences, Natural Sciences, LLL, Sept. 1993, UH)

Despite a slowdown that hit most of the rest of the world, East Asia produced 8.9 percent more goods last year than the year before, according to a World Bank report. Asian economies were roaring ahead at more than three times the pace of US production, which increased only 2.6 percent.

Since 1965, seven East Asian nations -- Japan, South Korea, Taiwan, Singapore, Thailand, Malaysia and Indonesia -- as well as the British colony of Hong Kong have increased their wealth at an average annual rate three times higher than Latin America and more than 20 times higher than southern Africa, said the report.

According to the report, called "The East Asian Miracle," East Asia is the only area that has made its people richer while narrowing the gap between rich and poor. The fastest-growing economies are the most equal: Japan, Taiwan, South Korea, Hong Kong and Singapore.

The report noted the East Asian emphasis on primary and secondary education. (emphasis mine)

"When it comes to improving the distribution of wealth, better education is more important than amassing it," said Michael Bruno, the bank's new chief economist. Government policies foster stability by keeping prices from rising too fast and currencies cheap enough so that exports sell, the report said. (Star-Bulletin, October 1993)

Another major piece of telecom research (6) was conducted by the Bank Street College of Education in New York with the following results: (Author's note: These results are from a nation-wide survey of 550 elementary, middle and high school educators who are active users of telecommunications technology for professional development and student learning. All of the educators who responded to the survey volunteered to participate.)

- These are the educators who have been pioneering the use of telecommunications activities in their schools, acting as facilitators and resource people for their colleagues.

- They represent a specialized group of educators: they are experienced and highly educated teachers, and are accomplished at integrating computers into their classrooms.
- These teachers work in schools that are well endowed with technology and have been using computer technology for instructional purposes for more than eight years.
- Communicating with other educators, accessing information, and combating professional isolation are the most highly rated incentives for using telecommunications as a professional resource.
- The most highly rated incentives for using telecommunications with students include expanding students' awareness about the world, accessing information, and increasing students' inquiry-based and analytical skills.
- More than two-thirds of these educators report that integrating telecommunications into their teaching has made a real difference in how they teach.
- Service offerings, expense, and ease of use are the three most important factors influencing their selection of telecommunications services.

In order for telecommunications to become a widely used educational resource, administrators and policy makers in the report concluded that the following must be implemented:

- teacher training and support;
- school and district planning for integration of telecommunications into instruction and administration;
- time in the school schedule for professional and student learning activities;
- effective assessment measures;
- financial support;
- multiple phone lines or local area networks in schools.

Similar challenges exist for the Developing World and the so-called Developed World.

"We've always approached development as though the agenda were to get Third World people consuming at the rate of First World people. But what I'm arguing now -- and I really believe this is a fundamental shift in our thinking -- is that we can no longer think of the world as divided into rich and poor, developed and underdeveloped, but rather as divided between the overconsumers and the under-consumers, vis-a-vis our ecological resources. The under-consumers just aren't getting enough, while the over-consumers squander far more than their fair share.

From this perspective, the over-consumers are every bit as underdeveloped as the under-consumers. That shifts the development education agenda fundamentally, because the main focus of development education efforts has been to push for increases in foreign assistance, with the idea that more money flowing from North to South will help the South overcome its poverty through increasing investment and growth.

But if we recognize that our predominant lifestyles here in the North are over-consuming; and that we are maintaining that lifestyle on a finite planet through the systematic extraction not only of financial resources, but more fundamentally, environmental resources -- energy, minerals and so forth -- from the under-consuming countries; and that we have been expecting the South to absorb an extra share of pollution, from greenhouse gases to shiploads of toxic waste -- it becomes clear that in order to reverse those flows we have to make changes in our lifestyle." (7)

Selected. Short Definitions

Developed (cf. Korten above)=overconsuming
Underdeveloped=underconsuming (see Korten's above quotation)
HyperLearning (HL) via PLNs (Personal Learning Networks)= "The ongoing fusion of **smart** tools. HL is the core technology and business process for the 21st Century economy. HL will replace education as we now know it in the New Economy."
-- De Anza TV Broadcast Announcement (9/93)

Personal Learning Networks (PLNs) = A proprietary Interactive Computer-Based Training (ICBT) which integrates a number of exciting new developments in electronic publishing, online collaborative learning, interactive multimedia, and accelerated learning technologies. In their present form PLNs combine the training advantages of Electronic Books, Virtual Collaborative Learning, Virtual Interactive Publishing, and Electronic Learning Journals.

HyperMation(HM) = "HM flips the focus from automation to intelligence and from information to knowledge. The two key requirements for putting hypermation into practice are: 1) Virtualizing with simulation techniques and Performance-Supporting via just-in-time knowledge and 2) learning systems."(13c) Some for-profit educational companies maintain that the emphasis should shift from structured learning systems to learning environments that encourage and invite exploration and discovery.

Information (Intensive) Industry: Is there a standard definition of the Information Industry? Are there operational measurements for the growth and development of the information industry. Dr. Perelman answers with a resounding "No." "By one estimate, two-thirds of US workers are in information-related jobs, and the rest are in industries that rely heavily on information" (1). So in reality today the information industry is rapidly encompassing everything. Therefore, preparing for the Information Age is really re-inventing/re-engineering (4) our entire social-economic-political system in order to usher in the Knowledge Society. "Indeed, the new source of wealth is not material, it is information, knowledge applied to work to create value. The pursuit of wealth is now largely the pursuit of information, and the application of information to the means of production."(13c)

IPSS: (Imbedded Performance Support System): Based on a case study for a typical large corporation, "Cost savings with an IPSS approach is $2.61 million--a 65 percent savings in the first year." (3)

Educational System Conceptual Model:
S<---C/M----->R

Where:
- Sender (S)=Teacher/Instructor/Server (Can also be an R)
- Receiver (R)=Learner/Student/Client (Can also be an S)
- "Pipe"/Conduit (C)
- Message (M)/Content carried by Conduit between S&R

Note: This model is an adaptation of Claude Shannon's path-breaking 1949 work in mathematical communications theory. (17)

4. DISCUSSION

Assuming that the major technological and financial challenges for implementing the GLN can be surmounted by the turn of the century, the remaining, major questions that need to be are: 1) What is the preferred transition path? 2) What are the key policy issues that need to be addressed? and 3) What is the appropriate curriculum and knowledge architecture for this evolving GLN?

Addressing each of the above in turn:

4.1 PROBABLE MIGRATION PATH

A satisfactory migration path is to trim-tab the marketplace and government actions in a few vital, highly-leveraged areas such as:

- SONET + ATM/EtherNet as the de facto standards (see also #1).
- Let entertainment build the basic HL infrastructure since education is dead/ended. (13a)
- Utilize places like Hawaii and Orlando as testbeds (social labs) to quantify the benefits from switching to digital data from analog voice and so forth.

4.2 POLICY IMPLICATIONS

The major policy suggestions are as follows:

- In order to meet the UN's goal (via ITU's Maitland Report) of a telephone within the easy reach of everyone, the Iridium Project (9) should be supported.

(Note: in the same bandwidth as consumed by an analog telephone, approximately 100 data channels can occur.)

- Ideas should be allowed to move as freely as reasonable across national borders. This means a minimum of governmental interference for the global exchange of legal ideas. (1)

4.3 CURRICULUM DEVELOPMENT AND RELATED MATTERS

In the Knowledge Society and the Information Age, the distinction between work (8) and learning (13) becomes very blurry as they progressively overlap. In order to survive in the international marketplace, all corporations must become effective **learning organizations** which can quickly and effectively adapt (and even anticipate) changes in the needs/wants of their clients/consumers/customers. These will also be *virtual* organizations (2) or virtually dead by the turn of the century.

4.3.1 IMPOSSIBILITY THEOREM FOR HL IN CYBERSPACE

So what will the "curriculum" look like for this Cyberspace University (CyberU) or *virtual* li'l Red Schoolhouse? To answer this vital question, the following Impossibility Theorem is posited:

NO one individual or even group of individuals can be smart enough to ***plan out*** *a structured curriculum with lesson plans, learning outcomes, and so forth for the GLN.*

In much the same way and for the same reasons that Nobel Laureate Frederick Hayek stated that the informational needs of socialism would eventually cause their economies to be succeeded by market-driven economies, free markets in minds as well as goods should determine the "curriculum" for the Global Learning Network (GLN). Therefore, the two most important aspects for the HL "curriculum" in the GLN are:

Learning How to Hyperlearn (front-end module for all HL)

•Asking the right questions (agenda determination)

Throughout history, many wise people have maintained that it's more important to ask tough question than to find easy answers to trivial problems. The definitive work on agenda determination is yet to be written, but it is an important skill that can and should be developed throughout the educational process. Naturally, there is a logical progression to the types of questions that student-participants might ask over time; however, allow me to pick one just for the sake of illustrating how HL questioning can and should work. Suppose a clever teenage boy in Outer Mongolia is worried about his future and wonders if others around the world share his angst. So how can this representative Citizen of the World satisfy his curiosity in the next century with well-formed questions and appropriately structured inquiry for searching worldwide databases and agent-selected file servers in a client-server architecture and network topology?

As was mentioned earlier, we'll temporarily assume (there are plausible solutions in process) away the nontrivial technical and financial challenges of placing an affordable PDA into the hands of this descendant of Genghis Khan. We'll also assume for the sake of argument that the language and human-machine interface problems have been satisfactorily solved by this international standard, wireless "PDA" which is automatically connected to the InterNet or just the Net for short.

"At the heart of the InterNet phenomenon is not terabytes and technology, but culture. The InterNet is really about the rise of not merely a new technology, but a new culture, a global culture where time, space, borders, and even personal identity are radically redefined. In a world obsessed with style and oppressed by the fear of the other and the alienation of the self, the InterNet represents a return to the fundamental dynamics of human existence: communication and community." (19)

There are even some who would go so far as to predict a reduction in violence and terrorism as the disenfranchised of the world gain a "voice" where they can be "heard" and recognized over the Net where every person can be a publisher. Building such electronic and virtual communities via intercultural communication of shared values is a vital part for co-creating our preferred future, according to Clinton's communitarian advisor Etzioni and many others.

•Finding appropriate answers to the most important questions.

So how would/could our representative for the Developing World proceed to find the "right" answer(s) to his/her question. S/he could tap into any one of the many electronic forums/chat lines where teens "hang out" in cyberspace. Subsequently, it's likely that E-mail correspondence would follow with several like-minded individuals.

In addition, a more mundane, but actual example of how HL is taking place today in Hawaii is as follows. Eighth grade students in intermediate/middle school (average age about 13) received an assignment from their science teacher to use HI, Inc.'s FYI (statewide electronic gateway) to locate reference works for their science fair projects. Students without access to home computers with modems (telecomputers) are able to use the terminals provided to the library of every public school in the State of Hawaii. For those children with home linkages to the electronic network, standard telecom protocol software permits convenient and easy access into FYI. From a series of menus, the children accessed the state's public library system, searched on key words, and then reserved the selected book(s). Several days later, computer-generated notices arrived via snail mail informing the students that their books were ready for physical pick-up at their closest library.

•Unlearning old and dysfunctional patterns of thought is also important in order to enjoy the benefits of HL.

Encouraging/Facilitating International Educators and others to continuously make HL easier, faster, and better.

A number of individuals and organizations are currently exploring the use of file servers with the new role of a teacher as a Master Sysop constantly monitoring the inquiries to the server for intervention and adaptation as required. These preliminary pilot studies should be encouraged as they hold the TQM (5) promise of continually improving the core HL **process**.

4.3.2 COROLLARIES AND LAWS OF HYPERLEARNING (HL)

Corollaries to the above mentioned Impossibility Theorem:

- •The First Law of HyperLearning (HL): The intelligence of the system is:
  - oo Network resident and
  - oo A positive function of the number of "cells" and interconnections in the system.
- •Failures should be expected and even celebrated, according to Tom Peters. (13c)

In a rapidly evolving, uncertain future, learning often and inevitably occurs through a guided trial and error process as one of the main ways of learning/knowing:

- • Analytical Reasoning
  - oo Induction
  - oo Deduction
- • Experiential (Trial and Error) (Note: This implies that the TQM (11) exhortation to DO IT RIGHT THE FIRST TIME may be unrealistic and even counterproductive in some/many instances where knowledge creation is in process.
  - oo real-world

"According to the great Austrian economist F. A. Hayek, 'All evolution, cultural as well as biological, is a process of continuous adaptation to unforeseeable events, to contingent circumstances which could not have been forecast.'"(13c)

- oo simulated, cyber-world

"Simulate first! may become the clarion call of hypermation: Simulate before you build. Simulate before you buy. Simulate before you employ. Simulate before you go into battle. . . Studies by President Jimmy Carter's commission on the Three-Mile Island nuclear power station accident in 1979 found a problem shared by many modern industrial operation control centers: Most of the work is routine, constant and boring. The operator's most important function is to solve unusual and thus unpredictable problems, and to manage the rare but critical disaster. The commission concluded that operators not only needed better-designed operating displays. They also required continual practice with simulators to hone their crisis-management skills." (13c)

5. CONCLUSIONS

Drawing from all of the above, a logical conclusion is that successful companies will look more and more like schools, and schools will be run more and more like corporations. Some innovative facets and predictions for this vivid and vibrant GLN are:

- •Strengthened family structure and values formation based on the foundation of strong families as the basic building block of healthy societies.
- •Enhanced sense of convivial community.
- •Pay-per-Lesson "newspanels" and Video (Interactive Multimedia) on Demand (VOD) education and training.
- •Mutual mentoring between North/Rich and South/Poor.
- •More healthy and symmetrical information flows between and among nodes with rapidly disappearing centers.
- •VSATs and USATs for remote villages and rural areas.
- •SONET + ATM/EtherNets will be ubiquitous.
- •IPSS (Integrated Performance Support Systems) will replace much of traditional higher education and executive training.
- •Global GNP will increase due to productivity gains while simultaneously reducing environmental pollution as the world turns towards a sustainable (vs. growing economy).
- •Increased/enhanced simulation and virtualization of nearly anything and everything.
- •Violence and terrorism will decrease as the disenfranchised "voices" of the world gain an interactive audience.

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6. SUGGESTIONS FOR FUTURE RESEARCH

Affordable Virtual Reality (VR) will continue to enhance the quality of universal education as a UN basic human right while continually decreasing its cost via TQM (15,16) applications and the relentless march of Moore's Law (annual doubling of constant cost computing power). In an electronic version of the previous physical Peace Corps, motivated Senior Citizens and others with some discretionary time could glocally telecommute to tutor individuals, groups, and indeed entire learning communities via the miracles of modern telecommunications technologies.

In this brave new *virtual* world, one of the most important skills is "learning how to learn." For this reason the completion of a proficiency-tested, front-end module is recommended for all new telelearners to become familiar with how to navigate cyberspace. In this virtual world, we'll have virtual offices (personal/team corporate workspaces) as well as virtual classrooms, and schools and corporations will continue to converge into **learning organizations** (cf. Peter Senge's works at MIT).

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FIBER OPTIC NETWORKS JOIN IN CHINA'S DRIVE FOR ECONOMIC DEVELOPMENT

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1. ABSTRACT

In 1984 the Independent Commission for Worldwide Telecommunications Development (the Maitland Commission) recommended ways of stimulating the expansion of telecommunications across the world. Since that time, China has made tremendous strides in developing and modernizing its telecommunications networks and services. The government of China has recognized the important role telecommunications can play in economic growth and, as part of its overall economic reform program, has accorded a high priority to the development of the country's telecommunications infrastructure. This paper looks at how China can expect to achieve network expansion, meet investment requirements, and overcome certain development constraints as it approaches the 20th anniversary of the Maitland report.

2. BACKGROUND

Before 1980, as with many developing countries, China placed agriculture and heavy industry above infrastructure on its list of development priorities. Among infrastructure projects, telecommunications was often treated as the poor step-child. In planned economies, projects that did not require tons of steel and concrete often did not get the attention of the central authority. Consequently, telecommunications development in China lagged behind other sectors with only .43 telephone lines per 100 inhabitants in 1980.

In recent years, it has been generally accepted by the development community that rapid and efficient transfer of information is essential for markets to function efficiently and stimulate commercial transactions and business enterprise. The worldwide recognition of this phenomenon has transformed the perception of telecommunications from a luxury service to a basic necessity for commercial development. In China, this new outlook meant the doubling in size of the network between 1986 and 1991, increasing the number of installed telephone exchange lines to 14.5 million. By 1995 the number of lines is expected to reach 50 million with further expansion to 100 million by the end of the century.[1] This emphasis on telecommunications infrastructure development can be seen as an integral part of China's overall economic reform program.

Since 1978 the government of China has pursued a multisectoral economic reform program aimed at increasing the role of market forces to improve economic efficiency. Rapid and efficient communications have come to be viewed as playing a central role in these economic reforms by providing: (i) better access to market information; (ii) more efficient domestic market operations through integration and coordination of the movements of goods and services and; (iii) access to the global economy, thereby, promoting more efficient and competitive international trade. As a result, beginning with the 7th five-year plan (1986-1990) and continuing through the 8th (1991-1995) and 9th (1996-2000) plans, telecommunications development has been given an increasingly high priority and is now viewed as a strategic investment requirement for future economic growth. This thinking was reinforced at the 14th Party Congress in October 1992, which concluded that the implementation of market reforms needed to be accelerated and that telecommunications development would play a key role in this process.

While plans for expansion are significant, the demand for services continues to outpace supply and the network continues to be characterized by severe congestion, particularly for long distance calls. In 1992, MPT's Directorate-General for Telecommunications reported only a 30 percent call completion rate over automatic toll circuits. The rate of completion for manual exchanges was significantly higher, however, queuing times were often in excess of several hours. The outdated analog technology comprising the bulk of the backbone transmission network is unable to cater to demands, and new digital transmission technology is required to balance the modern digital switching system which is rapidly being put in place.

3. CURRENT STATUS AND FUTURE PLANS OF THE TRUNK TRANSMISSION NETWORK

The Ministry of Post and Telecommunications (MPT) provides only 234,276 long distance circuits. This under capacity results in poor call completion rates between major commercial centers all along the long distance network. It is China's goal to have 520,000 long-distance circuits by 1995 and 1.3 million circuits by the year 2000. To meet this challenge, a high-capacity optical fiber cable (OFC) network is being developed to form the backbone of the national telecommunications trunk transmission network. The trunk line investment has been organized into 22 individual OFC projects. These projects are further organized into three campaigns. The first campaign links key provinces in the center axis of the country with north-south transmission facilities. The second campaign extends the north-south Beijing-Wuhan-Guangzhou line to link Zhenghou to Sichuan province in the southwest and Beijing to Heilongjiang in the northwest. East-west routes make up the third campaign. One trunk line links Fuzhou on the coast to Guizhou province. A second line connects Beijing to Lanzhou. And the third trunk line of the third campaign extends from Xi'an to Urumqi in the far west, following the old silk road. It is envisioned that one day the Xi'an Urumqi link will form part of a global fiber optic network. Upon completion of these trunk lines, all provincial capitals except Lhasa would be interconnected with a fiber optic network. The Tibetan capital would be connected to the network with a satellite link.[2]

These projects will include the installation of 33,000 kilometers of fiber optic cable to be installed between 1991 and 1995. Complementing the fiber optic network will be 15,000 kilometers of newly installed or rehabilitated microwave lengths along with 19 new earth stations for remote domestic and international gateway service.

MPT plans to integrate the domestic trunk transmission network into international fiber optic links. Beijing, Shanghai, and Guangzhou are each designated as international gateways, with 3,000 circuits apiece. MPT plans include connections with the following international systems:

- TPC-4 and TPC-5, for communications with the U.S. and Canada
- The China-Japan fiber link from Shanghai to Miazaki
- The Russia-Japan-Korea system.

Participation in systems to link the Guangzhou gateway to Singapore, Australia, Hong Kong, and Macao are also planned.

4. INVESTMENT REQUIREMENTS

It is conservatively estimated that unsatisfied demand accounts for 20 percent of installed capacity. Unsatisfied demand is between three and twelve times greater than the one million prospective subscribers registered on waiting lists. Interurban long-distance traffic is growing rapidly and has registered an average annual growth of 35 percent over the 1987 to 1991 period. Most recently this growth has increased to 60 to 70 percent per year in the major cities. This dramatic increase can be directly linked to the dramatic economic growth in China and the need for rapid interregional communications in a modern economy. This increased long-distance activity has resulted in very high levels of congestion in the network and foregone revenues for MPT.

The physical targets for MPT under the Eighth Five-Year Plan (1991-1995) have recently been revised to expedite provision of telecommunications infrastructure. The primary goals of the plan include: (i) increasing the penetration of telephone mainlines from 1.1 percent to 2.6 percent of population; (ii) increasing local switch capacity by more than 130 percent; (iii) expanding long distance switch capacity by 700 percent; and, (iv) augmenting long distance circuits by over 350 percent. In total, over 400,000 long-distance circuits, 33,000 kilometers of optical fiber cable, 28 million lines of local switching capacity and nearly a million long-distance switching ports will be procured and installed during the course of the Eighth Five-Year Plan. The total 5-year investment requirement for the sector amounts to over $12.9 billion. Expenditures for the 22 fiber optic projects alone, absent of any switching costs, are estimated at $1.3 billion, with $4 billion spent on transmission systems by the year 2000. The proposed targets for the Ninth Five-Year Plan period (1996 to 2000) are expected to be double those of the current plan.

Historically, MPT has financed two-thirds of its needs through internally generated funds with the remainder from local borrowing and bilateral assistance. The PRC is in a unique position among developing countries faced with massive infrastructure development requirements. A combination of indigenous manufacturing capabilities, a strong balance of trade, and a positive foreign currency reserve enable the PRC to be selective in its investment financing choices and tailor financing sources to the specific needs of the project.

In general, the PRC has adopted an investment strategy whereby the central government is responsible for trunk networks and international facilities, and the various local governments coordinate investment in the local network, including switching and the subscriber loop. This approach has resulted in faster growth for the overall network by having the specific telecommunications requirement directed by the level of government closest to that requirement.[3] In addition to government directed activities, MPT is actively considering options for increased private investment. These options include: (i) incentives for private networks and Township and Village Enterprises (TVEs) to connect subscribers in areas not served by MPT, (ii) encouraging investment by large user organizations with specialized needs; and (iii) issuance of bonds to subscribers. These and other initiatives are being explored by MPT with the view to mobilizing the necessary additional measures required for long-term sector development.[4]

Turning our attention to the trunk transmission network and the fiber optic projects, of the 22 projects currently planned, two are scheduled for World Bank funding, six will be funded through bilateral arrangements, two will be funded by the Asian Development Bank, and twelve will be financed by MPT. Each funding source comes with its own advantages and disadvantages. Multilateral institutions provide long-term financing at attractive rates of interest. However, their process is sometimes slow and funding is often linked to sector reforms. Bilateral arrangements can be negotiated quickly, but often tie the recipient to a specific vendor and technology. Finally, using internally generated funds impacts the country's foreign exchange position and may divert funds away from other telecommunications priorities which are less likely to attract outside financing. It appears that the PRC's balanced financing approach is effectively channeling resources to the trunk transmission network.

5. CONSTRAINTS

Although progress in the trunk transmission network has been dramatic, two factors are limiting fiber optic development in China. The first, a vestige of the Cold War, are export controls. MPT's ability to procure the most current technology depends on two conditions: (i) approval of export licenses by the home countries of Western equipment suppliers; and (ii) maintenance of PRC re-export controls consistent with those of its export sources. Export controls by NATO countries, Japan and Australia are coordinated through the Coordinating Committee for Export Controls (CoCoM). CoCoM is based on an informal agreement which established a strategic control and coordinating mechanism for technology transfer. Under current CoCom restrictions the export of a range of fiber optic technology to the PRC is prohibited. Among the most critical export restrictions are the prohibition against the transfer of 565 Mb/s systems. These restrictions have had an impact on the design of fiber optic networks in China and have hampered efforts at increasing capacity at an even more rapid rate.

To counter CoCoM regulations, the PRC has devoted significant resources toward the development of their own 565 Mb/s systems. The Wuhan Research Institute successfully developed such a system meeting CCITT requirements in late 1992. In January 1993, the first 565 Mb/s line in China using domestic equipment was installed between Shanghai and Wuxi, a distance of 167 kilometers.[5] Recently, CoCoM relaxed some restrictions and approved a 565 Mb/s fiber system linking Hong Kong with Shenzen. The export license is conditional on Hong Kong Telecom maintaining management control over the system and Northern Telecom being solely responsible for maintenance.[6] With the recent relaxation of restrictions and the success of the domestically produced system, it is now likely that remaining restrictions on the import of 565 Mb/s systems will be lifted. While it is useful for China to develop its own domestic telecommunications capability, reinventing the wheel due to export controls is not the most efficient use of China's resources.

A second constraint is the relative length of time it takes to fund a project through the multilateral banks. Several projects are scheduled for installation and are awaiting funding approval. The World Bank and Asian Development Bank have specific organizational objectives and operate very differently from bilateral export credits. It has taken some time for MPT to adjust to both the pace of World Bank and Asian Development Bank procedures and the volume of information these organizations require. Both organizations are involved in their first loan in the PRC telecommunications sector and as all parties involved gain experience, the process is expected to improve.

A final constraint is the growing need for externally supplied capital. While MPT has historically funded two-thirds of its investment requirements through internally generated funds, the exponential growth in telecommunications investment, and the ambitious development targets contained in the Eighth and Ninth Five Year plans will require that external sources of financing be identified and secured. For funds to continue to flow from the multilateral organizations, MPT must continue its reform processes. As for bilateral credits and direct external investment, funds will continue to flow only if China continues to successfully manage its economic progress and if other nations view the PRC as a stable place to invest.

6. CONCLUSIONS

In many ways, China has followed the Maitland Report's prescription for successful telecommunications development. It has identified a number of telecommunications sector objectives and has assigned development responsibility to the appropriate level of government. In addition, China has limited its exposure in terms of both technology and funding. The telecommunications network in China incorporates the full range of transmission and switching technologies and makes use of both domestic and foreign produced equipment, thus avoiding dependency on a single technology or a specific manufacturer.

In the area of funding, the PRC has diversified its funding portfolio making funding options the unique requirements of individual projects. By incorporating domestic and international sources, internal and external funding, and debt and equity investments, the PRC and MPT have insured a steady flow of funds immune from variation caused by interruption in any one market.

Most importantly, the leadership in the PRC has recognized that telecommunications is a strategic investment required for the continued economic development of the PRC. It is a critical factor for the success of investments in other sectors of the economy and will facilitate productivity gains as well as improving the delivery of services. The prioritization of telecommunications will ensure that MPT meets its long-term telecommunications development targets and that a consistent level of funding is provided.

If trends continue, by the year 2004 China is likely to have one of the most modern and extensive transmission networks in Asia. Yet even with continued development and sustained economic growth, China will remain a nation of contrasts with the old coexisting with the new. Traditional methods and an enormous rural sector will continue to influence China's development. In 1992 the Shanghai-Guangzhou fiber optic link, employing state-of-the-art technology, was completed in just 88 days. The Chinese accomplished this feat by mobilizing 200,000 laborers using largely manual methods. As China marches forward, the optical fiber and the shovel will both play a critical role.

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The development of Hong Kong as a telecommunications hub
and
a bridge to the China market

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Economic links between China and Hong Kong are getting tighter everyday. Hong Kong is the natural gateway to the PRC for Western companies and Hongkong Telecom is working closely with its counterparts in China to integrate the communication services of the two territories.

Ladies and gentlemen,

In the past twelve months, a great deal of investor attention has turned in the direction of China and Hong Kong.

Not all of that attention has been completely welcome. We could, for instance, have done without Mr Barton Biggs' extraordinary interventions — "maximum bullish" one moment, nervous the next.

But even ignoring Mr Biggs, 1993 witnessed a sustained inflow of cash to Hong Kong, which investors rightly saw as the gateway to China. Indeed, all the stock markets of East Asia have benefitted to some extent from the region's increased exposure to world scrutiny.

Everyone from President Clinton down has been talking about the Asia-Pacific region as the economic powerhouse of the 21st century. There is even speculation that it will supplant Europe as America's primary trading partner.

To those of us who live in Asia, this realisation has been a long time coming but it is no surprise.

You only have to spend a few days in Beijing or Bangkok or Guangzhou (Canton) to see that Asia is in the grip of an economic renaissance that the world has perhaps not seen since the Industrial Revolution of the late 18th century.

These cities, and many others like them, pulsate with energy. The pace of development is such that they seem to change before your very eyes.

One country in particular has garnered international acclaim for its fast-track development policy: China. The PRC is in the grip of unprecedented, and seemingly unstoppable, economic growth.

GNP rose by 12.8 per cent last year and an annualised 14 per cent in the first five months of this year. In southern Guangdong Province, last year's growth was 21 per cent.

Despite recent attempts to rein it in, the Chinese economy seems to have taken on a momentum of its own. The Chinese flair for business, so evident in Hong Kong, has clearly been lying dormant, just waiting for a chance to spring into exuberant life.

For Hong Kong, China's heady pace of development has been a tremendous windfall. Indeed, economic links between China and Hong Kong are now such that it is doubtful if either place could survive — certainly not thrive — without the other.

Bilateral trade between Hong Kong and China reached US$49.6 billion in 1991, constituting 37 per cent of China's total trade. Meanwhile, China's share of Hong Kong's global trade has risen from under 10 per cent in 1978 to more than 32 per cent in 1991.

More than three million people in Guangdong Province alone are reckoned to work for some 16,000 Hong Kong based companies and much of the territory's labour-intensive manufacturing has moved across the border.

China attracted a stunning eleven billion US dollars in external investment last year, of which 70 per cent is estimated to have come from Hong Kong and Macau.

Not to be outdone, Chinese investors have been snapping up prime commercial and residential property in Hong Kong, fuelling the most serious speculative price spiral for more than a decade.

Meanwhile, some 30 per cent of Hong Kong's currency circulates not in Hong Kong but in Guangdong.

Economic growth invariably stimulates a powerful demand for telecommunications. If that demand is met, further growth ensues.

Or perhaps it is rather the other way round. If the demand for communications cannot be met, growth will be artificially stunted.

No country that aspires to developed status can get there without making massive investments in its supporting infrastructure, as China has discovered.

If you look at the raw figures on telecommunications, China appears to be about where Hong Kong was in the late nineteenth century.

As recently as 1991, telephone penetration was reckoned to be one telephone for every 110 people.

But this conceals two facts. One is that the country has embarked on a huge, nationwide effort to improve its telecommunications infrastructure during the period of the current Five-Year Plan, which runs from 1991 to 1995.

The other is that, in areas designated for accelerated economic growth, the infrastructure is already just about on a par with Hong Kong's.

China spent US$2.8 billion on telecommunications in its seventh five year plan, which ran from 1986 to 1990. During the current five year plan, communications spending is expected to soar to US$12.5 billion.

Much of this investment is being channelled into modern telephone exchange equipment and into digital microwave and optical fibre circuits in an effort to meet the inexorable demand for telecommunications in urban and rural areas.

During the current Five-Year Plan to 1995, China is installing an additional 15 million telephone lines, almost doubling its 1991 capacity. That is a very ambitious target indeed.

Other projections in the plan are equally aggressive. The number of telephones will be doubled, increasing telephone penetration to two per cent.

Still tiny by the standards of developed markets, but this is a country of one billion people, eighty per cent of whom live in rural areas.

Figures such as these suggest that China represents perhaps the greatest business opportunity — and challenge — of this decade and beyond for global corporations.

Clearly anyone who takes business in China seriously must have a base either in, or close to, the country.

Hong Kong is in the unique position of currently being close to, and shortly being in, China. For this and other reasons it is widely perceived to be the natural gateway to the PRC for Western companies. Inevitably it has also come to play a pivotal role in East-West communications.

Actually, Hong Kong has been developing communication links with China for many years — long before the current boom was even a gleam in Mr Deng Xiaoping's eye.

With a population of six million, almost all of them Chinese with family links across the border, it could hardly have done anything else.

China has for a long time been the largest single source and destination of Hong Kong's international telephone traffic.

More than 1,000 cities and townships throughout China can now be reached via International Direct Dialling from Hong Kong and traffic between Hong Kong and China is growing at about 35 per cent a year.

Last year, for the first time, calls to and from China topped 50 per cent of all our international calls.

When you consider that Hong Kong people make a quarter of a billion international phone calls a year, that's a considerable volume of traffic.

With the opening up of China's economy in the past decade, the extent of our co-operative development efforts has greatly increased. Hong Kong is, for instance, the first of only two external territories in the world with direct optical fibre links to China.

With their higher bandwidth and performance characteristics, optical fibre cables have obvious advantages for financial institutions and other multinational customers that want to tie their China offices into their global communication networks.

In 1988, the first fibre optic cable was installed, linking Hong Kong and Guangzhou. This cable carries 47,000 voice channels at one time.

A second optical fibre cable was laid in 1992 to link Hong Kong with what has become almost its twin city, Shenzhen, located within sight of the border. The first 565 Mbps fibre optic link in China, it provides expansion of services for the whole South China region and now connects to a similar cable from Shanghai to Guangzhou.

With multinational corporations playing an increasing role in China's development, it became obvious that there would be a demand for international private leased circuits (IPLCs) between Hong Kong and the three largest Chinese cities.

High capacity IPLCs, providing guaranteed access to reliable circuits around the clock, are part of the operating environment a multinational company seeks when it makes investment decisions — when it builds a factory, for instance.

Currently, IPLCs terminating in, or transiting, Hong Kong support more than 70 global companies with operations in China.

Following successful installation of lower-speed circuits to many parts of the country, Hongkong Telecom inaugurated the first private 64 Kbps international data circuit between Hong Kong and Shenzhen in 1991.

A second followed in the same year linking Hong Kong and Shanghai, and subsequent links have been established with Beijing, Guangzhou.

A few months ago we celebrated the installation of the first Hong Kong to Beijing IPLC offering transmission at 128 Kbps.

Provision of IPLCs between Hong Kong and China has been greatly eased with the signing of "one-stop shopping" agreements between Hongkong Telecom and the three gateway administrations in Beijing, Shanghai and Guangzhou.

This makes it easier for the more than 500 companies that hub their Asian regional communications in Hong Kong to extend their networks to China. They can source services such as network planning, operation, facilities management and maintenance, whether or not they have a physical presence in the territory.

A recent development in China has been the inauguration of the country's first real packet-switched data network.

Chinapac, which went into operation in August, has 5,500 ports located in 31 cities, including all the provincial capitals. It replaces CNPAC, an earlier generation X.25 network that offered limited capacity and geographical coverage.

Chinapac uses the same technology as Hong Kong's Datapak packet-switched service, so it has been a relatively easy matter to link the two systems through Hongkong Telecom's international packet gateway.

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Satellite communications have become increasingly important in recent years, both as a means of extending communications to far-flung regions that lack adequate terrestrial connections, and to provide circuit diversity for international fibre links.

Hong Kong has been particularly prominent in the development of satellite communications. With 11 dishes, the territory's Stanley earth station is probably the biggest in the region.

Hong Kong's geography is particularly fortuitous, enabling us to use not only the Indian Ocean and Pacific Ocean Intelsat satellites, but almost all the national and regional satellites from Russia and Japan in the north to Indonesia and Australia in the south.

Again, partnership with China has been a key factor here. Asiasat 1, Asia's first regional satellite, is jointly operated by Hongkong Telecoms' major shareholder, Cable and Wireless, China's CITIC and Hong Kong's Hutchison. More recently, Hongkong Telecom has been invited to invest in APSTAR, a new China satellite initiative.

For most multinational companies, however, it is not so much its satellite links as its fibre capacity that makes Hong Kong attractive as a hub to multinational companies and as a gateway to China.

For example, the 2 by 560 Mbps Asia Pacific Cable, which was inaugurated in November, gave Singapore its second international fibre connection. But it was Hong Kong's fifth.

For multinationals that hub in Hong Kong, a major advantage of APC is that it provides fibre diversity to Japan, Taiwan, Malaysia and other Asian destinations.

As companies become increasingly dependent on telecommunications, the reliability of their networks — and the places that host their networks — looms larger and larger in their planning and decision-making.

Advanced digital communications technology can be exploited to deliver very high levels of reliability in local as well as international networks.

In Hong Kong, all exchanges are now fully digital and use software defined switches. Meshed optical fibre transmission systems interconnect these exchanges and an advanced overlay digital data network provides enhanced data services.

Since 1989 Hongkong Telecom has worked with building developers to encourage the provision of dual cable entry into buildings. Where a developer has put in dual entry, we have also provided alternate exchange access.

Customers using these buildings can obtain full diversity by having two different access routes and connecting to two different exchanges, eliminating single points of failure.

The telephone company also actively encourages developers to install dual risers so that diversity can be provided within buildings.

Major new buildings are now equipped with dual feed, dual entry, optical fibre access. In this scenario, the optical fibre connects telephone company equipment provided within the building to the telecommunications network using SONET dual ring technology.

For data transmission, we provide a digital data service based on a software defined, cross-connect switch and offering automatic diversity for high-volume users. We also have an ISDN Basic Rate Interface service in operation and a Primary Rate Interface service under test.

Other high bandwidth services include SwitchBand, a high-capacity, circuit switched service that enables a customer to have dial-up capacity of up to 2 Mbps on demand, and Multipoint LANline, a frame relay service that interconnects multiple local-area networks. Frame relay also plays an important role in the Global Data Management Service (GMDS) that Hongkong Telecom introduced in March, together with fellow members of the worldwide Cable and Wireless Group.

Many of these developing technologies will depend on a high availability, high speed domestic trunk network. Hongkong Telecom has already begun implementing SONET on its backbone network, replacing the current T3 technology while making maximum use of the 50,000 plus kilometres of fibre already in the ground.

This infrastructure will allow applications such as high-resolution image transmission, video telephony, full motion videoconferencing, high definition television and remote manipulation of interactive graphics to be supported economically by the public network, rather than provided as services on overlay network as at present.

Ladies and gentlemen, I think I have told you enough to convince you -- if you weren't convinced before — that Hong Kong has a special role to play in the development of business, financial and communication services between China and its export markets, not to mention its sources of overseas investment.

I'm proud of Hong Kong's — and Hongkong Telecom's — contribution to that role. We are, after all, a partly Chinese owned company. We operate in a territory that will presently become a Special Administrative Region of China. And we employ nearly 16,000 of the Chinese people who will become residents of that Region.

While 1997 does create a number of uncertainties for the future, let me assure you that we are enormously optimistic about the territory's future. Hongkong Telecom, for instance, has been investing around US$400 million a year in new plant - and continues to do so.

By aligning Hong Kong's traditions of free trade, first-class communications, open borders and the rule of law with China's vast resources of people and raw materials, I am confident that we are setting the scene for a period of unprecedented prosperity in East Asia.

Thank you.

"North American Information Infrastructure Developments in Canada, Mexico and the United States"

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Abstract

Here it is presented some of the important steps independently taken by Canada, Mexico and the USA towards building their information networks It is also mentioned how they are interconecting to possibly form a North American Information Exchange Network, now that NAFTA has been approved and how this "network of networks" initiative may have influence in other regions of the world

1. INTRODUCTION

Several countries around the world are making massive investments to exploit the synergies between telecommunications and computers Faster and more capable communications networks are being implemented to support their educational and R&D communities and, in so doing, they are building infrastructures which serve as a base to compete more effectively in the world's rapidly evolving information technology markets

This paper discusses some of the initiatives which have been taken in the U S A , Mexico and Canada These initiatives, while seeking to develop strong national information networks, are also seeking to establish mutually beneficial communications links amongst the three nations and, indeed with the rest of the world as well

The main socio-economic benefits expected from the various activities surrounding the design, implementation and utilization of high-speed, broadband networks can be briefly categorized as follows

- R&D and educational network user benefits

  This includes improvements in the content and interest level of curricula generally, in intellectual cross-fertilization amongst educators and researchers, in the sharing of expertise and facilities, in collaborative and/or concurrent R&D activities, in the diffusion of the results of R&D, in access to libraries and the sources of information, etc

- the creation of new employment

  This can result primarily from improved educational achievement, employee sense of fulfillment, job enhancement and increased information technology applications generally

- public sector benefits

  This can result, potentially, from less costly yet higher quality services (health, law and order and security), coordination amongst various levels of government, increased revenues, improved internal efficiency and productivity, etc

- industrial and trade benefits

  These would result mainly from increased productivity, process and inventory management, concurrent/distributed design and manufacturing, improved exchange of strategic product and market information and sales potential

In a nutshell, we are looking at the establishment of knowledge-based economies which will reap the benefits of more effective and efficient socio-economic activity in all sectors From a broader international perspective, the same type of benefits can accrue to groups of countries whose economies operate within a free trade context

2. NETWORKING IN THE USA

The history of the Internet in the U S A dates to the beginning of the ARPANET in 1969 Since then, many technological developments have shaped its future, and have influenced government procurements along the way To understand the present and future of the Internet in the U S A , it is worth noting a few milestones in its evolution

In 1973, Cerf and Kahn conceived the Transmission Control Protocol (TCP) as a means of interconnecting heterogeneous computers connected to heterogeneous networks The development of the protocol began in 1978, and Cerf and others pushed for the catenet model as early as 1980

In 1983, ARPANET split into a research component (ARPANET) and an operational component serving the Department of Defense (DoD) called MILNET, and TCP/IP (Internet Protocol) were declared DoD standards.

As the demands for networking support outgrew the mission and needs of the DoD user community, the need for another agencies to contribute to the nurturing of networking in the civilian sector became clear. In 1985, the National Science Foundation (NSF) committed support for helping establish five supercomputer facilities, with a network infrastructure aimed at allowing these centers to be accessed by the research universities in the U.S.A. This was the genesis of NSFnet. As NSFnet became an operational network used for much more than supercomputer access, there was no longer a need for ARPANET as an operational network aimed at users outside of the DoD user community, and it ceased to exist in 1989.

More recently, the NSFnet evolved into the National Research and Education Network (NREN) in 1992. NSFnet continues to be the backbone of NREN, connecting regional networks spanning different geographical areas. The objective of NREN is to support computer communication between all persons and organizations involved in open research and scholarly pursuits in the U.S.A.

NREN and its backbone (NSFnet) have evolved through a number of stages. In December 1992, the T1 NSFnet service ended and all NSFnet traffic now traverses ANS's T3 backbone infrastructure.

In contrast to the way in which ARPANET and ARPANET/MILNET were administered, several government agencies are involved in NREN. The success of the NREN, and the Internet in general, has been such that the portion of commercial traffic on the Internet is growing by leaps and bounds. As a result, NSF will soon cease the provision of a government-sponsored backbone for NREN, and regional networks will interconnect with one another through common carriers which are establishing bilateral agreements for traffic exchange. This by no means indicates a lack of interest by the federal government of the U.S.A. in supporting the establishment of high speed networks. The Clinton Administration's technology policy announcement last February included a major commitment to a national information infrastructure. Major elements of the Clinton Administration's plan include:

- a continuation and acceleration of federal investment in research in networking and computing technology, which will be carried out at universities, government labs, and industry.
- programs to provide partial federal funding for Internet connectivity of public-sector organizations and institutions.
- programs to provide federal assistance in the development of networked applications in such areas as health care, education, and manufacturing.
- continuation of testbed networks.

Subsequently, in September 1993, the Clinton administration announced its "Agenda for Action", relative to the construction of a National Information Infrastructure (NII). Among the benefits perceived are the following (mildly paraphrased):

- people could live and work almost anywhere, without foregoing opportunities for useful and fulfilling employment, by "telecommuting" to their offices through the electronic highway,
- the best schools, teachers and courses would be available to all students, without regard to geography, distance, resources or disability,
- services that improve America's health care system and respond to other important social needs could be available on-line, when and where they are needed.

The announcement recognizes the developments and system deployments already being initiated by the private sector and perceives a complementary and synergetic role for government in pursuing a common government-industry objective as follows:

- promote private sector investment, through appropriate tax and regulatory policies,
- extend the "universal service" concept to ensure that information resources are available to all at affordable prices, because information means empowerment —and employment,
- act as a catalyst to promote technological innovation and new applications. Commit important government research programs and grants to help the private sector develop and demonstrate technologies needed for the NII, and develop the applications and services that will maximize its value to users,
- promote seamless, interactive, user-driven operation of the NII. As the NII evolves into a "network of networks", government will ensure that users can transfer information across networks easily and efficiently. To this end, the government must reform policies and regulations that may inadvertently hamper the development of interactive and user-driven applications,
- ensure information security and network reliability. The NII must be trustworthy and secure, and protect the privacy of its users,
- improve management of the radio frequency spectrum, an increasingly critical resource.

- protect intellectual property rights. Investigate how to strengthen domestic copyright laws and international intellectual property treaties to prevent piracy and to protect the integrity of intellectual property,
- coordinate with all levels of government and with other nations, since information knows no boundaries,
- provide access to government information and improve government procurement, design federal procure policies for telecommunications and information services and equipment so a s to promote technical development for the NII and provide attractive incentives for the private sector to contribute to NII's development.

As commercial carriers start providing interconnectivity among regional networks, Internetworking in the U.S.A. will become market-driven for the provision of basic networking services (e.g., electronic mail, directory services). However, there is a strong research arm with the continuation of the gigabit test beds, which aim at developing networking technology to allow the exchange of information at gigabits per second.

3. NETWORKING IN MEXICO

Basic Telephony Services and the Maitland Report

The report of the Independent Commission for World-Wide Telecommunications Development focused on the importance of developing telephone infrastructure as a basic means for communication as well as on its contribution to a country's development.

TELMEX, the major provider of telephone services throughout Mexico, has sustained a 12% annual installation of new telephone lines over the last years. By July of this year, TELMEX had increased the digitalization of the Central Switches and installed 38 National and 8 International traffic Switches. The company's nationwide Fiber-Optic network links 25 of the main cities in the country, covering 70% of the national industry. When completed, the entire project will have placed 13,500 Km of optical fiber cable, linking the 54 main cities. At this point, the task is 50% complete.

Rural Telecommunications

Providing telecommunication services to rural areas has also been the concern of both developed and developing countries. The Mexican Institute of Communications (IMC) has developed a methodology for applying new communications technology to various social interest areas. In this case, a social interest area is a broader concept which includes rural, suburban, extremely poor, ethnic, remote, isolated, or areas of difficult access. The objective is to have a methodology which considers socio-economic, geographic and infrastructural factors, thereby providing technological alternatives for the process of applying communication services to social interest areas. This methodology (a project sponsored by the Organization of American States) is designed to be applied to any geographic region, and is a decision-making tool for telecommunications administrators responsible for the application of new technologies in the provision of the required services. Mexico has successfully applied the plan this year in the Mexican state of Sonora where several areas are now able to communicate.

Other Carriers

TELECOMM is the Communications and Transport Secretary (SCT) operator for the Morelos and Solidaridad (soon to be launched) satellite systems. In addition to exploiting the C and Ku bands, TELECOMM offers X.25 data transport services via Vsat and terrestrial services via TELEPAC. It also provides the Telex and Telegraph networks.

INFRATEL, an offspring of BANAMEX (one of the two largest banks in the country), offers excess Banamex communications circuits for other uses.

Networks (The Mexican Internet)

Aside from the private networks established by the major companies, there have been separate efforts by national educational institutions to create a Mexican version of Internet. The names of the major players are Universidad Nacional Autónoma de México (UNAM), Instituto Tecnologico de Estudios Superiores de Monterrey (ITESM), MexNet, Red Universitaria de Teleinformática y Comunicaciones (RUTyC) and Consejo Nacional de Ciencia y Tecnologia (CONACyT). All of these have nationwide networks (not only regional, as is the case in other countries), which has created a strong competitive environment among them for leadership.

Peculiar as it may seem, the only institution with the obligation (moral) and the power to organize and promote the Mexican Internet is CONACyT, the equivalent of the US National Science Foundation. Unfortunately, there seems to be a lack of understanding of the importance of this fact because the network responsibilities lie in the hands of a minor level official who, though blessed with as much enthusiasm as any person might have, found that there are too many layers to the top, and that his decisions have little, if any, weight.

In May of 1993, promoted by UNESCO's Intergovernmental Informatics Program IIP and coordinated by Colima University in Manzanillo, Mexico, a group of national and foreign experts from the academic, government and business sectors met to propose possible actions towards the development of the public Mexican universities on informatics and telecommunications. One of their recommendations was to facilitate the integration of a nationwide digital backbone data network, to allow access to the academic community, to provide value added services like data banks, and to set up the proper structure to optimize and manage the network.

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Recent developments show that the establishment of the Mexican Internet may be getting closer. In the last week of September, 1993, a proposal for a Regulatory Plan for the Development of Academic Internets was presented to the National Association of Universities and Higher Education Institutions (ANUIES). This occurred a few days after a symposium held in Vancouver Canada, a follow-up meeting of the Wingspread Conference referred to below, which had decided to develop a North American Distance Education and Research Network.

So far, thanks to the TELMEX digital overlay network, several universities are now interconnected, as shown in figure 3.1

according to a UNAM expert, the actual needs of the Mexican academic network do not require the use of high speed links like E1. The feeling is that high bandwidth will be required in a few years. We think that with the distance learning and video applications among universities, the E1 links will be falling into place one by one, in some cases replacing the existing E0 links.

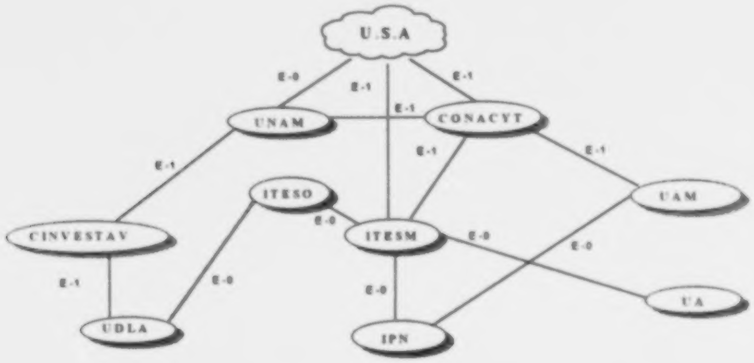

FIGURE 3.1

Source: TELMEX

4 NETWORKING IN CANADA

The introduction of networking facilities in Canada to serve the research and education communities began several years ago through what has become known as CA*net. Growth in the demand for this network has provoked consideration of the possibility of evolving towards megabit and, eventually, gigabit speeds.

In response to an increasing recognition of the value of broadband communications to a variety of knowledge-based activities, of the resulting increasing demand for appropriate broadband services and of the rapid emergence of the necessary enabling technologies, a series of consultations involving participants from Canada's industry, education and research communities, as well as from the federal and provincial governments, began in 1988 and culminated in the establishment an executive committee to guide the development of a Canadian high-speed network, as it was initially called. Thus, CANARIE (Canadian Network for the Advancement of Research, Industry and Education) was launched in 1993. Its primary mission is "to support the development of the communications infrastructure of an knowledge-based Canada and, in so doing, contribute to Canadian competitiveness in all sectors of the economy, to wealth and job creation and to our quality of life". A group of nineteen leading organizations from Canada's research and business communities (called the "CANARIE Associates") sponsored the final development of the CANARIE Business Plan. NGL Nordicity Group Ltd. (a Canadian consulting firm) was selected to assist in the development of that plan, working in close association with CANARIE's Executive Committee, Working Groups and Associates. The Business Plan, and supporting documents, were released in December, 1992.

The Business Plan envisages three successive phases:

Phase 1: from April, 1993 thru March, 1995, with the following main tasks:

- Upgrade and operate the national R&D and educational network (CA*net)
- Plan and establish a high-speed experimental test network
- Initiate product and service development

Phase 2: from April, 1995 thru March, 1998, with the following main tasks:

- Operate the experimental network
- Stimulate the development of new networking technologies, products, applications, software and services

- Continually upgrade the R&D and educational network

Phase 3: April, 1998 thru March, 2000, with the following main task

- Migrate applications and technologies to operational networks

An overview of the Business Plan is given in Figure 4-1. Sources and use of funding are shown in Table 4-1. While the federal government was instrumental in initiating the project and provided seed funding, it is noteworthy that the project is now largely industry-driven and financed.

CANARIE Inc. has been incorporated as a not-for-profit organization to implement the CANARIE Business Plan. A President has been appointed and membership has increased from the original 19 organizations to about 70. Phase 1 is now well underway and CANARIE members are actively considering and developing — indeed, already using in some cases — many of the new applications listed earlier in Section 1 of this paper.

The implementation of CANARIE will take into consideration the fact that regional networks of varying capability already exist in the Canadian provinces. From an architectural point of view, CANARIE will encourage the enhancement of these regional networks and overlay the nation with a backbone network serving to interconnect them.

Figure 4-1
CANARIE Implementation Plan

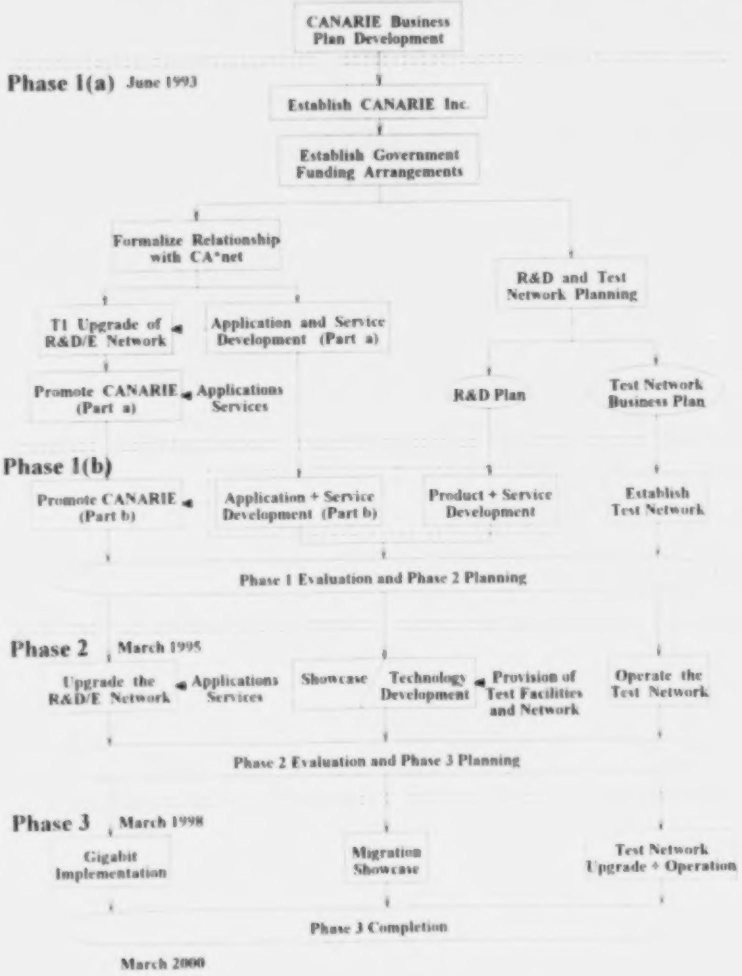
CANARIE Business Plan Development
Phase I(a) June 1993
Establish CANARIE Inc.
Establish Government Funding Arrangements
Formalize Relationship with CA*net
R&D and Test Network Planning
T1 Upgrade of R&D/E Network
Application and Service Development (Part a)
Promote CANARIE (Part a)
Applications Services
R&D Plan
Test Network Business Plan
Phase I(b)
Promote CANARIE (Part b)
Application + Service Development (Part b)
Product + Service Development
Establish Test Network
Phase 1 Evaluation and Phase 2 Planning
Phase 2 March 1995
Upgrade the R&D/E Network
Applications Services
Showcase
Technology Development
Provision of Test Facilities and Network
Operate the Test Network
Phase 2 Evaluation and Phase 3 Planning
Phase 3 March 1998
Gigabit Implementation
Migration Showcase
Test Network Upgrade + Operation
Phase 3 Completion
March 2000

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Table 4-1
CANARIE ACTIVITIES
Sources and Uses of Funds (C$ Millions)

Activity	Contributor	Phase 1	Phase 2	Phase 3
R&D/E Network Upgrade and Operation	Federal Government	5	20	TBD
	R&D/E User Fees	3	30	
	IT sector fees and investment	—	—	
	Private Shared Assets	—	—	
Cooperative Product/Service Development	Federal Government	20	40	TBD
	R&D/E User Fees	—	—	
	IT sector fees and investment	16	40	
	Private Shared Assets	—	—	
Test Network Conctruction and Operation	Federal Government	3	20	TBD
	R&D/E User Fees	—	—	
	IT sector fees and investment	1	30	
	Private Shared Assets	50	200	
Administration and Overhead	Federal Government	—	—	TBD
	R&D/E User Fees	—	—	
	IT sector fees and investment	2	10	
	Private Shared Assets	—	—	
TOTAL, C$ (Millions)		**100**	**390**	**400**

5. TRI-PARTITE COLLABORATION

Network development within Mexico, the USA and Canada, has been uneven and essentially independent of each other; the USA has a significant lead in many areas, including hardware, protocols, technology diffusion and applications. Moreover, internal domestic coordination of such developments has not been as comprehensive as it might have been. The resulting patchy development has given rise to a variety of network interconnection problems, within and amongst the three countries. Between Mexico, and the USA, for example, there are six academic network interconnection points: Ensenada-San Diego, Mexicali-Calexico, Juarez-El Paso, Monterrey-Houston, Mexico City-Houston and Mexico City-Boulder. For broadband applications, Mexico follows the CCITT E1 (2,048 Kbps) recommendations whereas Canada and the USA follow the T1 (1,544 Kbps) arrangement. Thus, while some cross-border interconnections have been effected at the local or regional independent (ie. non-national) network level, the need to resolve such problems at the national level led to more formal consultations amongst the three countries. These were initiated in September, 1992 at an inaugural MEXUSCAN meeting convened at the Canadian Embassy in Washington, D.C. Representation at the meeting was mainly from the scientific and academic sectors.

In parallel with the above, other consultations were underway. Since the NAFTA parallel agreements had not considered the education sector, a steering committee involving governmental and educational authorities from all three countries attended a conference held, in September 1992, at the Wingspread Centre in Racine, Wisconsin, under the auspices of the Johnson Foundation and the Office of Academic Programs of the US Information Agency. Its objective was to chart a course of action for North American cooperation in higher education for the coming decade. Close to one hundred and fifty delegates from the three countries attended. A Trilateral Task Force on North American Collaboration in Higher Education was established to develop a strategic plan incorporating the principles adopted by the Conference. In addition, it was agreed to organize a Symposium in Vancouver to review and to implement the plan. The Symposium met in September, 1993, and agreed to:

1. Establish a North American Distance Education and Research Network (NADERN).

2. Form an Enterprise/Education trilateral mechanism to examine issues related to mobility, portability and certification of skills.

3. Establish programs to explore and develop trilateral higher education collaborative activities in priority areas
4. Establish an electronic information database, in each of the three countries, on initiatives and resources relevant to trilateral cooperation
5. Strengthen and expand North American study programs and promote trilateral linkages for undertaking research and curriculum development

An important initiative identified, inter alia, for consideration in 1994 concerns the establishment, for an initial period of seven years, of a Council of North American Business and Higher Education, to conduct research, development and training on a trilateral basis. The Council is expected to pursue the implementation of the agreements reached in Vancouver.

While a specific consultative agenda on all other aspects has not yet been established by the MEXUSCAN mechanism, it is felt that in order to realize a truly effective North American networking capability, a number of issues will have to addressed and resolved, including the following:

- Technical: -interconnection points and standards
  -reliability, security and privacy
  -traffic analysis
  -technological migration (towards gigabit capability)
- Managerial: -organizational set-up
  -financing
  -access and accounting arrangements
  -security and privacy

While some arrangements and accommodations had to be achieved for the independent network interconnections alluded to earlier, achieving fully national and cross-border Internetworking capabilities represents a significantly greater challenge.

6. BROADER RAMIFICATIONS

It is expected that an eventual integrated North American network will gradually migrate to, say, a 100 Mbps capability in the not-too-distant future, and eventual evolve to gigabit levels. Falling regulatory barriers in the USA are gradually introducing the traditional telephone carriers —with their significant resources— into the broadband and multimedia sectors for broad public consumption. Greater access to the public at large and the potential commercial rewards will definitely provide an even greater impetus to the coordinated development of networks at all levels —local, regional, national. The effect would likely overflow into neighboring countries and others as well. At the same time, significant developments are taking place in Europe and in Japan. Developments such as the projected Columbus II fiber optic submarine cable that will link South, Central and North America and the Caribbean with Europe as well as the trans-Pacific fiber optic cables currently under installation, will constitute additional high-capacity links for global Internetworking. It would not be surprising if the University of Guatemala and the others in South America were to find their way into NADERN, facilitated by the Solidaridad Satellite System whose footprint covers large portions of the subcontinent. What we are witnessing in essence, is the "broad banding" of Internet, which has already in practice achieved world-wide penetration.

It must be remembered, however, that in many developing countries, the establishment of more modest 64 Kbps capabilities, let alone broadband, will take significant time and will stretch their resources considerably. Nevertheless, many of these countries, including those from the Pacific Rim attending this Conference, should encourage access to Internet and its eventual broadband materialization. Great technological and educational, as well as commercial and industrial, possibilities await them.

Finally, it is easy to speculate how the United Nations and its various Agencies could benefit operationally from the greater use of international networking in support of their assistance and developmental programs, peace-keeping operations, information diffusion, etc. in achieving better world order and understanding.

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The Big Three Contenders—FDDI, ATM, and Fast Ethernet (100Base-T)

An Evaluation of Three Front-Runners in High-Speed, High-Performance Networking Technologies

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Among the many higher speed networking technologies being talked about today, three are ahead of the pack and also lead in the development of standards. The three technologies are 100-Mbps Ethernet, fiber distributed data interface (FDDI), and Asynchronous Transfer Mode (ATM). This article provides a detailed comparison of these technologies to help you determine how each will fit your network environment. It also offers some guidelines as to which applications are best served by each of the three technologies.

Introduction

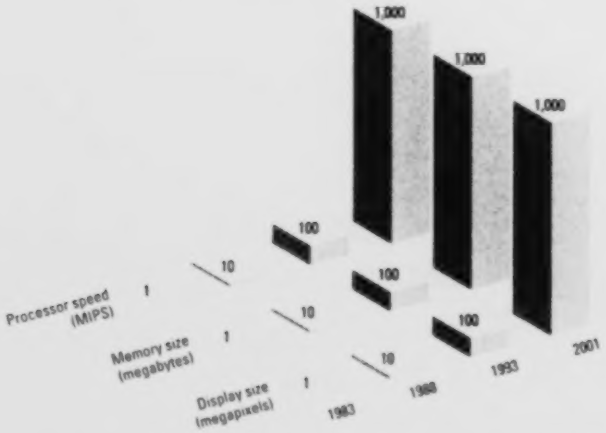
In the last nine months there has been a proliferation of proposals by various companies to create new standards for high-speed networks. Although 10-Mbps Ethernet and 16-Mbps Token Ring have been satisfactory for 85–90 percent of all existing applications to date, growth in four important areas is fueling the need for even higher speed networking technology:

- End-station processing power (see Figure 1)
- Application complexity and capability
- File size (see Figure 2)
- The number of network users/end stations

First there was FDDI; now we're hearing about proposals for ATM at 25, 52, 155, and up to 622 Mbps. There is also 100-Mbps Ethernet, also known as 100Base-T, Ethernet switched at 10 Mbps, and bridge-per-port Ethernet. There are also proposals for full-duplex Ethernet and Token Ring at 64 and 100 Mbps.

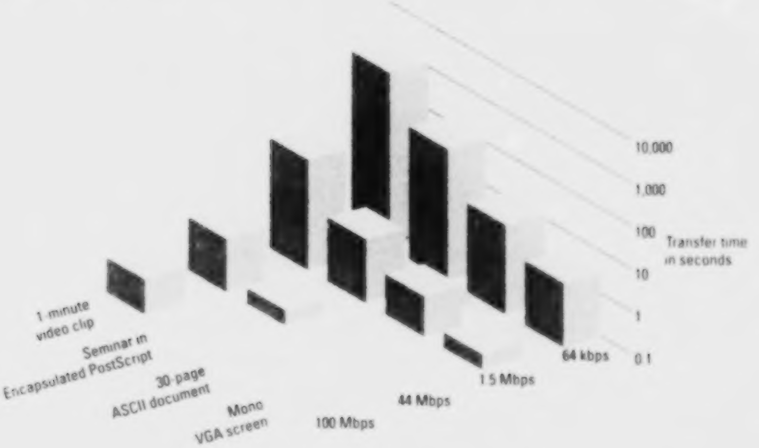
When you are faced with a bewildering array of technologies, you have to ask which of them will survive into the future and which really make sense for your network. We hope this article provides answers that will help you plan, design, and install higher speed networks.

Figure 1. *Logarithmic Increases in Workstation Processing Power*



Workstation processor speed, memory size, and megapixel range have increased logarithmically in the past ten years. If this trend continues as expected, the same performance metrics will increase more than tenfold by the year 2001. Processor speed will be well over 1,000 Mbps, and typical end-station memory and display size will each be well over a gigabit.

Figure 2. *Common File Type Transmission Speeds*



The need for greater bandwidth is also being driven by the growth in application file sizes and the time it takes to transmit files at various speeds. Four types of files and their relative transmission times are shown in Figure 2.

Evaluating High-Speed Networking Technologies

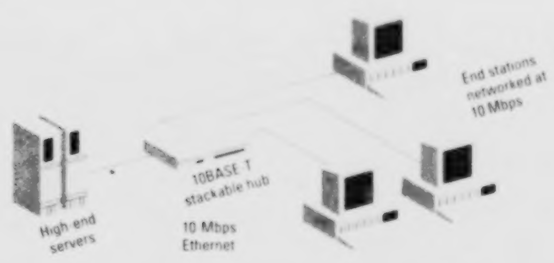
You should focus on the following criteria when evaluating higher speed networking technologies:

- Choose the simplest approach that will satisfy today's needs and has a clear migration path to future technologies.

- Look for products that are standards-based, interoperable, and available from market leaders at a reasonable cost.

- Products should be easy to install—fit well into the existing networking infrastructure, topology, and structured wiring scheme—and capable of evolving as the technology advances.

Figure 3. *A Handicapped High-Speed Network*



Much of the capability of high-end servers may be wasted if they are connected over a 10-Mbps Ethernet link to end stations that are not equipped with high-performance adapters.

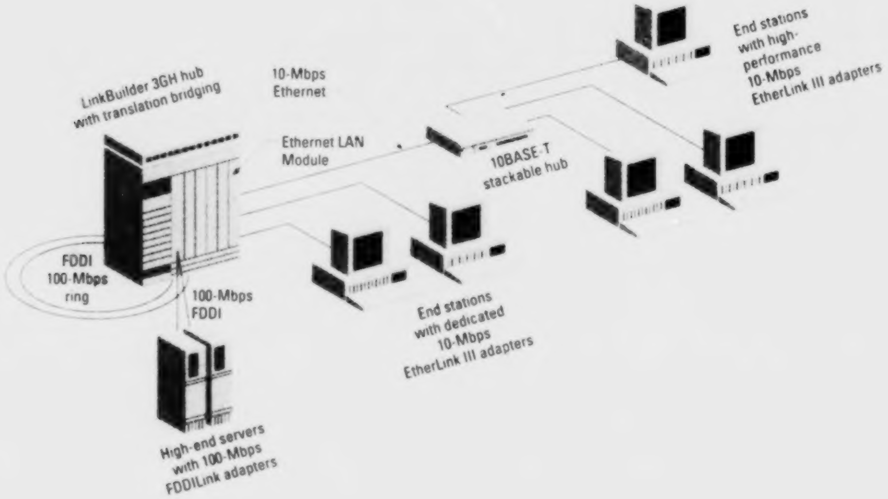
- Look for standards-based manageability such as SNMP and SNMP management applications.

- Look for technologies with the best cost/performance ratio.

The cost/performance ratio is perhaps the most important criterion. What is the actual cost of the installed network, and what is its actual performance? Low cost does not always result in the best cost/performance ratio. For example, consider a network with high-end servers that cost $20,000–$25,000 and are capable of sustained network throughput of well over 80 Mbps. If these servers are equipped with only 10-Mbps adapters, server performance is restricted to a 10-Mbps network pipe, and much of the investment is wasted (see Figure 3).

In contrast, by installing 100-Mbps FDDILink™ adapters in the servers, providing high-performance 10 Mbps at the desktop with EtherLink® III adapters, and using the LinkBuilder 3GH hub with the Ethernet LAN Module or NETBuilder II bridge/router, these high-end servers become the cornerstones of a truly high-performance network (see Figure 4). Although this type of installation requires a higher initial investment, it improves overall network performance for workstations while allowing the high-end servers to fully utilize their available power. The net result is high performance throughout the network as opposed to a network with isolated high-speed locations. In the future, the same architecture could be used with 100-Mbps Ethernet and ATM.

Figure 4. *A Fully Utilized High-Performance Network*


LinkBuilder 3GH hub with translation bridging
10-Mbps Ethernet
Ethernet LAN Module
10BASE-T stackable hub
End stations with high-performance 10-Mbps EtherLink III adapters
FDDI 100-Mbps ring
100-Mbps FDDI
End stations with dedicated 10-Mbps EtherLink III adapters
High-end servers with 100-Mbps FDDILink adapters

A high-speed FDDI backbone in a LinkBuilder 3GH hub with high-end servers and end stations equipped with high-performance adapters results in an overall high-performance network.

There are three choices among the existing and proposed high-speed technologies that meet these evaluation criteria:

- 100-Mbps Ethernet (100Base-T)
- 100-Mbps FDDI
- ATM at 155 Mbps

These three technologies are clear leaders in terms of existing and proposed standards development. But which of the three do you choose? When do you choose one over the other? The next several sections describe in detail 100-Mbps Ethernet, 100-Mbps FDDI, and ATM at 155 Mbps and compare them in terms of access method, network services, frame size, network topology, maturity and interoperability of standards, and cost.

Access Methods

100Base-T, FDDI, and ATM use three distinct access methods, each of which has benefits in particular applications.

The current IEEE 802.3 proposal for 100Base-T is based on the same access method that Ethernet has always used—carrier-sense multiple access/collision detection (CSMA/CD). CSMA/CD is a simple, easy-to-use access method which is well suited to general LAN usage. With CSMA/CD, an end station senses the line and, if there's no traffic, begins transmitting. If another end station begins transmitting at the same time and a collision occurs, both stations back off and run algorithms that allow them to regain access to the network, one end station ahead of the other. Because all end stations on a contiguous Ethernet network contend for and share the available bandwidth, Ethernet is known as a shared bandwidth network.

FDDI uses a timed, early release, token-passing scheme. A token is circulated around the network continuously and all end stations have fair access to it. Every end station is guaranteed access to the network every time it has control of the token. The target token rotation time is negotiated at initialization. This negotiated approach allows higher bandwidth users to see the token more often than lower bandwidth users, giving high-performance end stations greater access to the network (or a greater share of bandwidth) for transmitting data. The allocation of bandwidth is useful when mission-critical data must be sent regularly or in a LAN that has a mixture of bandwidth requirements across end stations. FDDI is also considered a shared bandwidth network.

ATM uses cell-based switching or switched access. With this technique, switched virtual channels and switched virtual paths are used to set up and control access to the ATM network. When a station wants to access the network, a request is made to set up a virtual circuit between the transmitting and receiving end stations. All the bandwidth on the circuit is available to the end station in small increments, or cells. The end station can request as much bandwidth as it needs to suit its transmission requirements. The network's ATM switches grant the request for the connection if there is sufficient available bandwidth. This kind of access guarantees bandwidth when the end station needs it and is particularly useful for transporting real-time, interactive communication such as voice or video. ATM is known as an allocated bandwidth network.

Network Services

100Base-T is an asynchronous network which is designed to handle asynchronous traffic—essentially bursty data going from point A to point B. Asynchronous communications is best suited for transmission of data that is not delay sensitive (e.g. data files, stored image files). With asynchronous transmission bandwidth is not guaranteed. Data is sent when the access rules for transmission allow (e.g. in ethernet when no other station is in contention). For this reason it is good design practice to limit the number of stations on any given Ethernet segment so that the desired performance can be achieved. With higher bandwidth users fewer stations should be placed on a given segment. Recent developments have also demonstrated the use of Ethernet for passing video signals from point A to point B in a single-direction application—for example, sending a video signal for playback as a video clip. This application can work on 100Mbps Ethernet so long as the network is not saturated with traffic.

FDDI handles both asynchronous and synchronous traffic. It can be used for high-speed data transfer of bursty data from point A to point B, the transfer of large files and real-time video clips, and limited bidirectional interactive communication. Synchronous mode FDDI is achieved in station management (SMT) by adding some changes to the controlling software. Synchronous mode FDDI invokes a priority token which guarantees synchronous stations a minimum percentage of the total network bandwidth. With the combination of timed token rotation and synchronous bandwidth allocation FDDI is suitable for supporting real-time interactive communication between a limited number of end stations.

ATM with its cell-based switching can be used for all types of traffic—data, voice, and video. ATM service is known as isochronous communications. Isochronous communication guarantees transmission at fixed intervals for a guaranteed minimum time. This ensures a minimum and regular flow of bandwidth. The small cell size (covered later) aids this process by controlling latency. This combination of service through the virtual path/channel connections allow ATM to be used for realtime interactive communication without degradation due to network loading.

Frame Size

Frame size is one the key differentiators between 100Base-T, FDDI, and ATM.

100Base-T, as proposed today, will use a standard maximum Ethernet 1,500-byte frame (range: 64–1,500 bytes), the same format used by 10-Mbps Ethernet. Standard frame size is maintained to simplify the migration to 100-Mbps Ethernet and to maintain the existing knowledge base built on 10-Mbps Ethernet. 100Base-T is suited to the transfer of large files because its 1,500-byte frame size reduces fragmentation and thus lowers overhead per unit of data sent.

FDDI uses a maximum 4,500-byte frame size (range: 64–4,500 bytes). This is very efficient when large files are transmitted from point A to point B because fragmentation and overhead are kept to a minimum. FDDI is best suited to transfer large files at high speed.

ATM with its 53-byte cell size is tuned for real-time interactive communication that will carry voice, video, and data simultaneously. Large frames are not required for interactive communication; small cells that can be switched efficiently through an ATM-type switch to arrive at their destination regularly are most important. Because of the need for increased fragmentation, the smaller frame size of ATM makes it less efficient than 100-Mbps Ethernet or FDDI to transfer large files at high speed.

Both FDDI today and 100Base-T tomorrow will be largely high-speed data transmission networks, while ATM will be ideally tuned for real-time interactive communication.

Network Topology

The overall nonbridged network diameter for Fast Ethernet will be 250 meters, so it will be used primarily in a local area network that runs from the wiring closet to the desktop—a high-speed, low-cost floor distribution system. In most instances, the 250-meter maximum diameter precludes its use as a campus backbone network. Although bridging will allow Fast Ethernet to connect physically separate locations, it will not be as efficient as using a single, contiguous network for the backbone.

FDDI can cover a nonbridged network diameter of up to 100 kilometers. For this reason, FDDI has become the network of choice for high-speed backbone networks tying together buildings and campuses. FDDI over copper is now being used to seamlessly fan out to server clusters and to the high-bandwidth end users who demand the greatest efficiency for high-speed data transfer.

ATM will be able to carry real-time voice, video, and data for distances of a few meters or thousands of kilometers. It will thus be useful as a wide area network and campus backbone and, in the future, all the way to the desktop.

It is important to note that Fast Ethernet, FDDI, and ATM map perfectly into a structured wiring environment. Networks that are following the EIA/TIA 568 building wiring standard, using a star wire topology with a hub in a centrally located wiring closet and spokes fanning out to the desktop, will be well prepared for high-speed networks. The spokes of this type of network are limited to 100 meters, which is well within the copper transmission distances for all three technologies.

Standards

The FDDI high-speed networking standard has matured over the past ten years and is the only standards-based networking technology at 100 Mbps that is actually available today. FDDI over unshielded twisted-pair, category 5 cable (also known as CDDI) is available now. Interoperability among more than twenty-four vendors' products, including 3Com's, has been demonstrated, and the formal sign-off of the twisted pair–physical medium dependent (copper distributed data interface (CDDI)) effort is imminent. FDDI includes SMT, which provides a built-in measure of network management.

Fast Ethernet and ATM high-speed networking products and standards are less mature. The emerging Fast Ethernet standards effort began about a year ago in the IEEE 802.3 working group. It proposes to take the existing 10-Mbps Ethernet and boost the wire speed to 100 Mbps to create a network for desktop delivery of high-speed services over a distance of 100 meters. Fast Ethernet is expected to be fully standardized within the next year to year and a half, with fully interoperable products from multiple vendors expected in calendar year 1994.

ATM has existed in concept for wide area networks for some time. The efforts of the Consultative Committee for International Telephone and Telegraph are ongoing, with progress on the international front since the mid-1980s. In 1991, the ATM Forum was established to promote ATM implementors' agreements. The ATM Forum consists of a group of companies, including 3Com, that are interested in promoting ATM. The ATM Forum is rapidly moving to refine the needs of true interoperability for ATM. There are still many details to be worked out, including what kind of signaling scheme will be used over copper cabling, how to resolve the differences between wide area networking and local area networking, such as the different addressing schemes that are used for each, and also how to handle virtual paths in local area networks where end stations typically use discovery services for broadcast and multicast addressing.

Cost Comparison

FDDI is leading the way down the cost curve as the only fully standardized high speed technology available from multiple vendors. This trend is being driven by the sale of more and more FDDI backbone, server, and end-station connections, as well as competitive pressures with more than forty vendors shipping interoperable products. Higher integration on the part of FDDI silicon vendors is also reducing costs. Today FDDI backbone connections cost as little as $5,600 (the NETBuilder II FDDI module), adapters are available for under $1,000, and concentrators have dipped into the $500 per-port range for CDDI.

Fast Ethernet as currently proposed is expected to be a very low cost technology. Fast Ethernet has the benefit of leveraging the existing 10Mbps technology. Predicted costs are in the range of roughly $400 per 32bit bus adapters and approximately $250 - $300 dollars per hub port. These predicted low costs are dependent on the 100Base-T standard remaining as simple as possible, maintaining Ethernet's simple yet effective CSMA/CD access method.

Early implementations of ATM are a little more expensive. The connection cost for ATM today ranges from about $3,000 to $4,000 per connection. ATM adapter costs have fallen below the $2,000 mark however ATM hub port costs remain somewhat higher at approximately $2000 and up. ATM cost reduction will rely on the proliferation of standard components, higher levels of integration and widespread adoption (increased volume).

The Right Technology for the Application

For general LAN usage, 4- and 16-Mbps Token Ring and 10-Mbps Ethernet are probably the networks of choice. 100Base-T will be best suited for customers who want greater than 10- or 16-Mbps performance in a desktop LAN environment at the lowest possible cost while preserving compatibility with their existing systems. 100Base-T, if properly specified, will preserve the installed cabling infrastructure and will run on category 3 cabling. However, 100Base-T as a standards-based technology is far from being completely defined as a multivendor interoperable technology. 100Base-T will be best suited as a high-speed desktop distribution system, as opposed to a backbone technology.

Because of its relative simplicity, 100Base-T is expected to mature very rapidly. In addition, the standards effort calls for 10/100 switchable adapters, which can be installed as 10-Mbps adapters and then turned up to 100 Mbps as needed.

Table 1. *Comparison of High-Speed Networking Technologies*

Cable Type	10BASE-T/ 10-Mbps Ethernet	Token Ring	100BASE-T 100-Mbps Ethernet	FDDI/ATM
Category 3 UTP (voice grade)	√	√	√	—
Category 4 UTP	√	√	√	—
Category 5 UTP	√	√	√	√
Category 5 screened STP	√	√	√	√
IBM type 1 STP	√	√	√	√
Fiber-optic	√	√	√	√

FDDI is ideal for reliable, high-speed campus backbones and high-speed data transfer to servers and to the desktop if necessary. FDDI is the choice for mission-critical applications where maximum control and uptime are important. FDDI's fiber/distance capability lends itself to campus as well as metropolitan area networks. It also provides a very strong measure of fault tolerance and control of the network via SMT.

See Table 1 for a summary comparison of the three high-speed networking technologies.

If you plan to migrate eventually to real-time interactive communication and install ATM, stick with structured wiring, choose cabling media that will support ATM from 100 Mbps up to 622 Mbps, at a minimum category 5 (for 100-Mbps and possibly 155-Mbps ATM), or fiber-optic cable (for 155–622 Mbps ATM).

ATM will be best suited for applications that require multiple services—voice, video, and data within a single network pipeline in the wide area network, the campus LAN, and the desktop environment. ATM at 622 Mbps is also well suited as an ultimate backbone. The likely first installation of ATM will be as a campus backbone which will support both FDDI and 100Base-T. ATM will also become a wide area networking backbone once interoperability and standard interfaces are fully developed. Finally, when reasonable costs and applications demanding interactive communication begin to appear, ATM will fan out to the desktop.

Key to the installation of ATM at the desktop is marrying ATM to the various protocol stacks available today. A study of ATM support of the Internet Protocol, which was started by the Internet Engineering Task Force, is in progress. The study is looking closely at the various protocol stacks to see how they can be integrated with the various adaptation layers of ATM. This is one of the major open issues in ATM that must be well understood before ATM can be widely used as a desktop technology.

Conclusion

The three technologies discussed in this article—100Base-T, FDDI, and ATM—are complementary, and 3Com is committed to supporting all three. 3Com has always been committed to Ethernet and is currently leading the 100-Mbps Ethernet standards effort. The company is currently shipping a line of FDDI products, including the FDDILink adapter, the LinkBuilder FDDI workgroup hub, the NETBuilder II high-performance modular bridge/router, and the LinkBuilder 3GH hub—an FDDI concentrator and bandwidth manager. And 3Com is an active member of the ATM Forum developing standards for this important emerging technology. When ATM is standardized, interoperable, and cost-effective, it will be at the top of the high-speed networking hierarchy as a WAN and backbone technology, with FDDI and 100Base-T at the level below.

Rural Radio communications system for Access to ISDN
- TDMA Radio Based ISDN -

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Tokyo Japan

1. ABSTRACT

ISDN Plans are being implemented throughout the world including developing countries. However, there are countries which have many rural areas isolated from access to ISDN services.

In the trend toward the globalization of telecommunications, it is important to consider that such rural areas be also embraced in the global progress of ISDN implementations. In order to fill the telecommunication gap, it is necessary to provide rural areas with economic, advanced digital telecommunication systems that can be integrated with ISDN networks.

As a solution to that requirement, we propose to build an ISDN network connected to UHF-band multiplex radio communication system with TDMA subscriber radio channels.

This paper describes an ISDN network connected to an economic TDMA radio communications system and the technical requirements to implement the TDMA radio based ISDN in rural areas.

2. INTRODUCTION

The TDMA radio system is a digital radio communication system which is capable of time division multiplexing without collisions of signals from a number of transmitting stations, in order to allow effective use of radio frequency resources and to provide rural areas with economic access to ISDN.

For this purpose, the TDMA radio system has the following advantages:

- To provide economic, sophisticated digital communication services to rural areas with low traffic densities, enabling their access to ISDN services.
- To configure flexible communication networks suited for individual rural areas.
- To enable easy, low-cost maintenance only at sites of equipment installed.

3. NETWORK CONFIGURATION

3.1 Configuration of the System

The TDMA radio system is capable of exchange the calls of telephone sets, facsimile machines and data terminal equipment of the subscribers who are geographically distributed over rural areas. Figure 3.1 shows a basic configuration of the TDMA radio system.

3.2 System Description

(1) Base Station

The base station consists of an antenna, radio (T/R) equipment, DAMA/EXC equipment and maintenance (MD) equipment. Figure 3.2-1 is a photograph of the base station.

The DAMA/EXC equipment is connected to the exchange through two 2M primary interface lines. The maintenance equipment is a personal computer which can store all the system parameters and traffic information records of the TDMA radio system. The MD can also gather and store failure information of subscriber stations.

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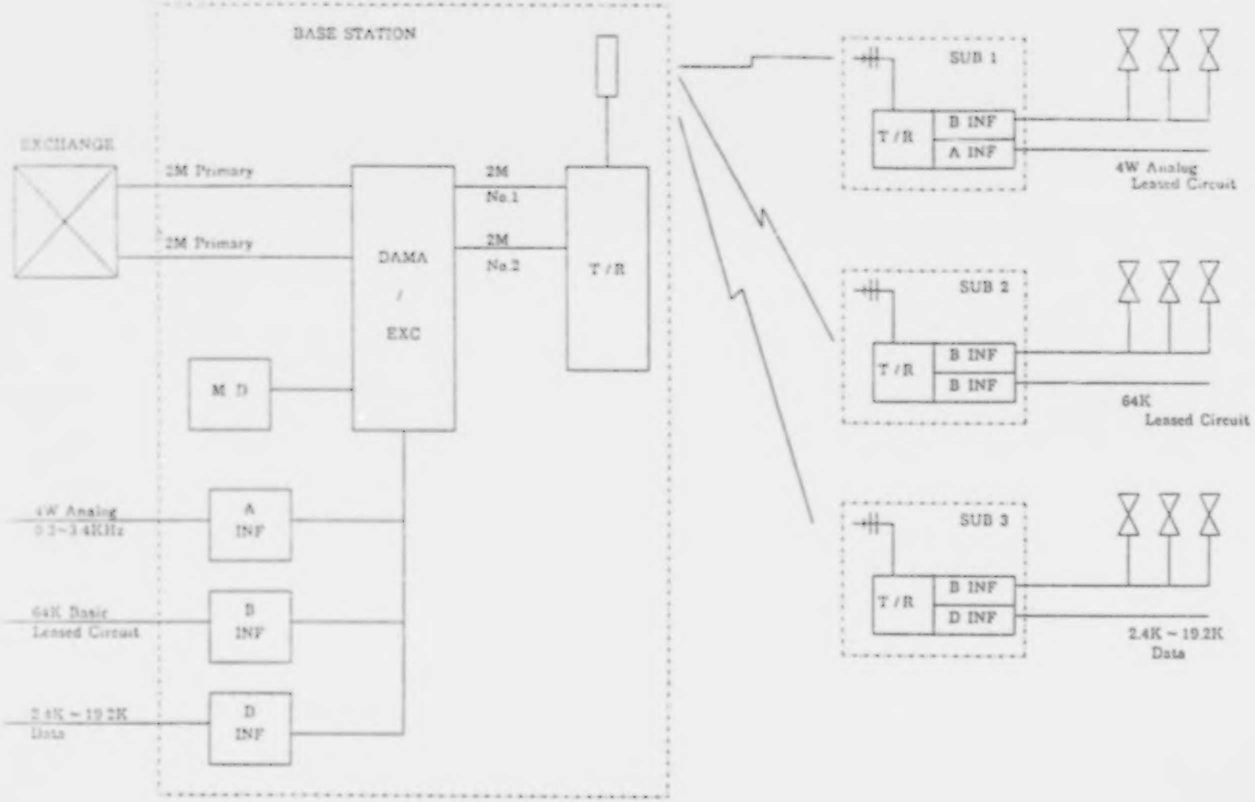

BASE STATION
EXCHANGE
2M Primary
2M Primary
DAMA
/
EXC
2M
No.1
2M
No.2
T / R
M D
4W Analog
0.3~3.4KHz
A
INF
64K Basic
Leased Circuit
B
INF
2.4K ~ 19.2K
Data
D
INF
SUB 1
T / R
B INF
A INF
4W Analog
Leased Circuit
SUB 2
T / R
B INF
B INF
64K
Leased Circuit
SUB 3
T / R
B INF
D INF
2.4K ~ 19.2K
Data

Fig. 3.1 TDMA radio system configuration

(2) Repeater Station

The repeater station is installed on the radio path between the base station and a subscriber station. In practice, the repeater station consists of two subscriber stations interconnected back to back. Therefore, the repeater station is provided with the functions of a subscriber station.

(3) Subscriber Station

The subscriber station consists of an antenna, radio (T/R) equipment and subscriber interface equipment. The subscriber interface equipment is available in the following types:

(a) Analogue interface
(b) Basic interface
(c) Data interface

Figure 3.2-2 is a photograph of a cabinet type subscriber station. Figure 3.2-3 is a photograph of a slim-rack type subscriber station.

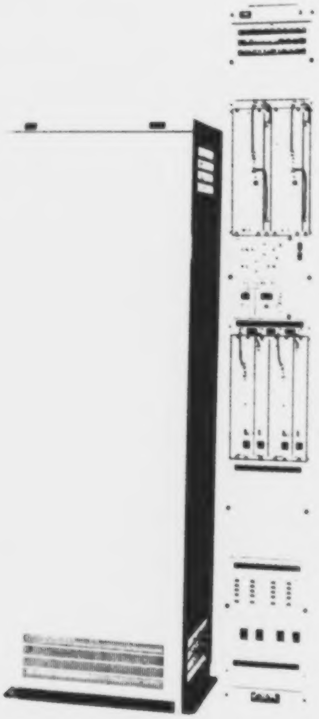


Fig. 3.2-1 Base Station

JRC
TDMA
SB9082

Fig. 3.2-2 Cabinet type
Subscriber station

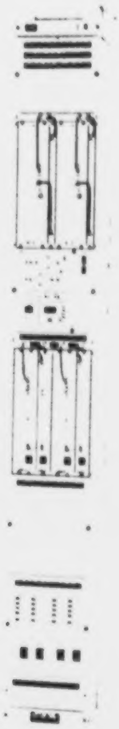


Fig. 3.2-3 Slim rack
Subscriber station

4. SERVICES AND SYSTEM PARAMETERS

4.1 Services and Interfaces

The fundamental service that the TDMA radio system provides is a digital bit stream service. However, conventional 2-wire and 4-wire analogue interfaces can also support this system for service transient from an analogue system into a digital system.

(1) Analogue Interface

- (a) 2W interface
- (b) 4W interface

(2) Basic Interface

- (a) 2B+D subscriber interface
- (b) 2B digital leased circuit interface

(3) Data Interface

- (a) Asynchronous interface
- (b) Synchronous interface

4.2 Exchange Interface

The TDMA radio system can be connected to a public service network exchange through a 2.048 MHz primary interface. Signal transmission is made through an ISDN primary PBX interface.

4.3 System Parameters

The system parameters of the TDMA radio system are as follows:

(a) Multiple access : Demand/Pre-assignment

(b) Access channels : 60 channels

(c) Maximum subscriber capacity : 512 subscribers

(d) System service range : Up to 500 km

(e) Delay time adjustment : Automatic

(f) VF coding : PCM 64 kb/s, A-law(CCITT Rec. G. 711)

(f) Traffic information recording : By MD (maintenance device)

(h) Fault information gathering and recording: By MD

5. ISDN INTERFACE

5.1 ISDN Network Interface

The connection between TDMA Base Station and ISDN Network is performed by primary interface through satellite or microwave link, shown Fig. 5.1-1.

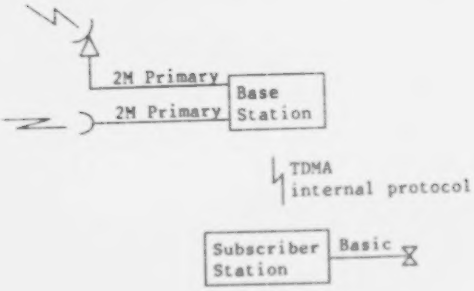


Fig. 5.1-1 ISDN Interface

5.2 ISDN Facility

The TDMA radio system passes following ISDN Facility.

(a) Called party number indication

(b) Calling party number indication

(c) Called party subaddress indication

(d) Calling party subaddress indication

(e) User-user information transmission

(f) Bearer capability (BC)

(g) High layer capability (HLC)

(h) Low layer capability (LLC)

5.3 ISDN Subscriber Interface

ISDN Subscriber Interface uses basic interface, while D channel packet service is optional, currently not available.

5.4 Basic Physical Interface

(a) Multiplex Channel : 2B+D

(b) Wiring : Metallic 4W

(c) P-P Connection : 600m max.

(d) P-MP Connection : 100 ~ 200m max.

(e) Transmission Speed : 192k b/s

(f) Transmission Line Code : 100% AMI Code

5.5 Primary Physical Interface

(a) Multiplex Channel : 30B+D

(b) Wiring : Metallic 4W

(c) Transmission Speed : 2048k b/s

(d) Transmission Line Code : HDB3

6. DAMA SYSTEM

6.1 DAMA System Configuration

DAMA system consists of DAMA master in the base station and DAMA remote controller (DARC) in the subscriber station. A time slot assigned for common signaling channel (CSC) is used for communication between DAMA master and DARC, the data speed of common signaling channel is 64kb/s. DAMA and DARC hardware uses a latest 16 bit micro processor which enables low cost and high performance.

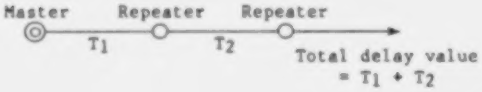
6.2 CSC Protocol

CSC protocol consists of layer 2 protocol and layer 3 protocol. Layer 2 protocol is a simplified LAPB protocol and Layer 3 protocol is a simplified ISDN protocol which carries user ISDN signaling.

6.3 Automatic Delay Adjust

The TDMA radio system has automatic delay adjust function which can adjust the delay time difference between master station and each subscriber station. The sequence of automatic delay adjust is as follows:

- Master station or repeater station always sends total delay value to subscriber station



- Subscriber station receives the total delay value and sends delay adjust code to upper station.
- Upper station measure the delay adjust code and returns a delay adjust information to the subscriber station.

6.4 Down Load Function

After successful delay adjust, MD computer sends all information to the subscriber station, and subscriber station can enter service mode.

7. BIT ERROR CONTROL

The TDMA radio system designed for ISDN is required better quality of bit error ratio than speech only system. The TDMA radio system uses bit error correction function by adding error check code for each block, the following bit error correction scheme is integrated in this TDMA system.

Bit error correction code : shortened BCH (511,493)
Code length : $n = 278$
Information code length : $k = 260$
Check bit length : $m = 18$
Bit error correction : $t = 2$
Generation polynomial : $G(X)=(X^9+X^4+1)(X^9+X^6+X^4+X^3+1)$

8. MAINTENANCE DEVICE

The hardware of maintenance device is a economical personal computer which controls and supervises the TDMA radio system. Main menu of the MD is as follows:

- EXC Data Maintenance
- DAMA Data Maintenance
- Subscriber Data Maintenance
- MD System Maintenance

For example, the menu of DAMA Data Maintenance is as follows:

- Setup DAMA Management
- Setup Subscriber Line Management
- Setup Subscriber Station Management
- Radio SV/CONT Management
- Setup channel Management
- Test Control
- Trouble Information
- Call State Management
- Clock Management
- Traffic Information
- Program Information

9. ASIC

For the TDMA radio system, five C-MOS ASIC are developed, to realize low cost and low power.

(1) FRAMER : TDMA framer for transmission and receive.

(2) SIG SW : Signal transform

(3) EC : Error correction

(4) LIF : Line interface logic

(5) DATA INF : X.50 data interface

Fig 9-1 shows the ASIC and Fig 9-2 shows the PC board mountd these ASIC.

JRC
6DLTEC0010
MB632134
9241 E00
SB9917

Fig 9-1 ASIC

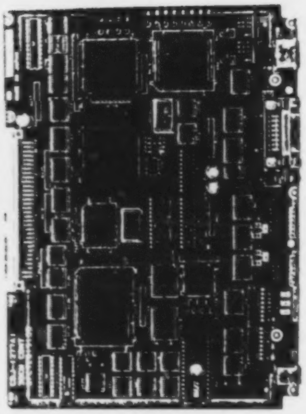


Fig 9-2 PC Board

10. CONCLUSION

Recently, the importance of rural areas is recognized again in Japan. It is a renewed understanding that rural areas will need the same information traffic in the quality and volume compared to those in large cities when they are provided with an advanced telecommunications infrastructure. This is the same case in Asian Pacific region. The TDMA radio based ISDN can be implemented as such an advanced telecommunication infrastructure which is economically available to rural areas. The TDMA radio system can surely be integrated with satellite communications system to provide wide-area information services for administrative communications, disaster prevention, and advanced business communications.

RAIN ATTENUATION STUDIES FOR SATELLITE COMMUNICTION IN TROPICAL REGION

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1. Introduction

Experience of the last few decades has shown that economic development of a nation goes hand in hand with development of telecommunication resources. The importance of telecommunications in the economic development of the country and its relationship to increase productivity, efficiency and enhancement of the quality of life is well known. Therefore, an expanded telecommunications network would benefit developing countries like Malaysia. Furthermore, the process of improving and expanding telecommunications networks will create a major market for telecommunications equipment. A more comprehensive telecommumnications system will increase local and international traffic to the advantage of the operators.More world trade and other contacts will increase understanding between different nations.

In the past, telecommunications have been neglected in favour of other sectors such as agriculture, water and roads. Telecommunications should be regarded as a complement to other investments and an essential component in the development process which can raise productivity and efficiency in other sectors and enhance the quality of life. Telecommunications also play an essential role in emergency and health services, commerce and other economic activity, in public administration, and in reducing the need to travel. There is, moreover a clear link between investments in telecommunications and economic growth. Telecommunication systems can also be used as a channel for education, for disseminating information, encouraging self-reliance, strengthening the social fabric and sense of national identity, and contributing to political stability.

2. Requirements for Telecommunication in Remote Areas

At present there is a wide disparity in the extent and quality of telecommunication services between urban and remote areas. This reflects differences in economic capability, historical experience and in the priority given to investment in this sector. Malaysia has manage to create efficient telecomunications systems but not extending into more remote areas. This has resulted in uneven distribution of telephones throughout the country. In many developing countries service may not be available even to those close to a telephone exchange. The services may be out of order for long periods. The causes of these and other shortcomings may include inadequate equipment and maintenance, or lack of trained staff.

The more remote areas of developing countries pose special difficulties because of the distances involved, the terrain and sparse population. Profitability alone is an inappropriate criterion for investment in these areas: indirect benefit has to be taken into account. Since operator's main business and source of profit are in urban areas, the incentive to invest there will be strong. If the service in these areas is neither efficient nor comprehensive, operators may see little point in providing service to remote areas.

Both developing and developed countries require as many telecommunications tools as possible to deal with the diverse and difficult conditions they must face in bringing service to rural and remotes areas. Providing telecommunication services to rural areas, can facilitate many development activities including agriculture, industry, education, health, etc. Rural areas not linked to the telecommunications network are unable to fully participate in social and economic development programmes. Among the socio-economic benefits to be gained from the introduction of rural telecommunications are increased local employment, reduced transport cost, more efficient marketing, more readily available emergebcy services and reduced sense of isolation.

In planning future telecommunication networks, consideration should first be given to the development of rural areas as an essential part of a harmonized evolution in a given country. Rural telecommunication planners should consider the latest technological advances and evaluate the possibility of their introduction in this part of the network.

In Malaysia, agricultural production continues to contribute a decreasing share of the economic output but provides employment for a large proportion of the population. Morever, the Malaysia's Industrial Master Plan has focused on resource-based industrialisation. However, agriculture suffers from a major problem i.e. the low price of its products, most of which is sold in raw form. Information and knowledge have emerged as the critical strategic factors for growth, increasing value-added and the competativeness in the modern economic environment. Therefore, providing telecommunication services to rural areas will have significant long-term influence in lifting the agricultural sector from its present low quality, low productivity and low cost status.

Telecommunications can improve efficiency and productivity by making price information available to farmers and helping in the timely delivery of products. It can also attract industry and allowing the decentralization of economic activities away from major cities. Furthermore, creation of new projects based on natural resourcest in remote areas can necessitate the urgent installation of few communication facilities.

3. Effect of Rain on Satellite Communication Systems

Conditions in remote and rural areas suggest that satellite or radio systems may offer cost effective solutions. However, most satellite equipment is designed for use in advanced countries with temperate climate and may not suit conditions in Malaysia having a tropical climates. For example rain is a major consideration in the design of satellite communication systems. At present the operating frequencies are 6/4GHz and 14/12GHz and in the near future it will be operating at 30/20GHz and higher frequency bands.

Studies have shown that the communication systems operating above 10GHz are very vulnerable to attenuation due to rain especially in the tropical region which experiences heavy rainfall and relatively bigger raindrops compared to the temperate region. Attenuation due to rain can seriously reduce the reliability of the communication system operating in Malaysia. Currently most of the data on induced rain attenuation and its effect on communication transmission are based on situations and conditions in the temperate region which cannot be reliably applied to the communication condition in tropical region.[2] Thus, there is an urgent need for microwave propagation studies to be carried out in tropical regions such as Malaysia where the effects of rain on microwave transmission increase exponentially as the frequency increase.

3.1 Rain Induced Attenuation

The calculation of rain induced attenuation will be briefly described. It is convenient and practical to express the relationship between specific attenuation A (dB/km) and the rain rate R(mm/hr) approximately according to the power law [1,2]

$$A = aR^b \qquad (1)$$

where a and b are dependent on the transmission frequency drop shape, drop temperature and drop size distribution. Rain dropsize distribution measurements are already underway at UTM together with the point matching programme in order to calculate specific attenuation (dB/km) at given frequency and rain rate. The constant a and b have already been obtained based on locally collected data [3 , 4]

Equation 1 gives the specific attenuation i.e. attenuation per km of the signal path through rain. In order to obtain the total path attenuation i.e. the reduction of the signal after passing through rain, the spatial profile of the rain must be determined. Therefore, the macrophysical structure of rain events especially typical rain cell sizes and distribution of the sizes are required. These data are to be obtained from the weather radar at Meteorological Department.

In general, assuming inhomogeneous variation of rain rate, total path attenuation is given by

$$AT = A\, r_L \quad \text{dB/km} \qquad (2)$$

where r_L is the reduction factor. For earth-space link, the total length of the slant path in the rain rate for satellite communication link is obtained by determining the rain height. For the terrestrial link, the total path length will be the distance between the transmitter and receiver.

3.2 Rain Dropsize Distribution Measurements

The rain drop size distribution measurements have been conducted by using a tipping bucket rain gauge and distrometer. The rainfall data aquisition system is made up of a field station and a central station. The field station consists of a tipping bucket raingauge and a low power 16 bit Microcomputer-based Data Aquisition Unit (MDAU) and an IBM AT personal Computer with EPROM reader and hardware and software at the central station to receive and process the information from the MDAU. The recording and processing of the drop size data is performed using the RD-69 distrometer . The transducer which is exposed to the rain, transform the momentum of the drops into an electric pulse which is roughly proportional to the mechanical momentum of the raindrop. The processor will eliminate the unwanted signals such as an acoustic noise due to strong winds and surrounding noise. The data from the processor can be directly connected to the Personal Computer using the ADA-90 adapter. The measurements have been carried out for more than one year.

Rainfall drop size distribution (DSD) data is important for the accurate calculation of rain induced attenuation [2,5,6]. A DSD has been measured in Kuala Lumpur using the distrometer described above since 1991. The specific attenuation (dB/km) of electromagnetic wave operating at 13GHz, 16GHz and 23GHz were calculated using the Kuala Lumpur log-normal parameters and the scattering coefficients obtained from the University of Bradford, United Kingdom. Comparisons have been made with results derived from CCIR [1].

Fig. 1 shows the values of specific attenuation at 13 GHz, 16 GHz and 23 GHz for Kuala Lumpur and CCIR DSD models. The Kuala Lumpur model gives higher attenuation than CCIR model. This is probably due to the DSD model itself where for Malaysia, it consists of larger drops than the CCIR model as the rain rate increases.

3.3 Rain Height Measurements in Tropical Region

In order to determine the rain induced attenuation on the satellite communication links in tropical region, the rain height has to be known. The chosen site for the initial slant path propagation measurements is at the Universiti Teknologi Malaysia, Kuala Lumpur located at latitude 3^0 10' 40" North and longtitude 101^0 42' East with height above mean sea level at 36m. AR1 S band radar donated by the Malaysian Air Force (TUDM) have been modified to be used to determine the rain height statistics. The radar operated at 2.8 GHz with peak and average power of about 640kw and 400w respectively.

During periods of rain, the radar will be used to monitor the variation of reflectivity with height. Studies of vertical reflectivity, Z profiles have shown that the value of Z displays very with little variation with height below a certain transition level and this region is predominantly rain. The proposed radar is to detect this transition level. Thus the radar antenna would be pointing at 90^0 elevation angle. For tropical rain, a suitable frequency would be in the S band. The radar will be range gated with a resolution of 100m. The 0^0 isoterm for Malaysia is approximately 5km and with 100m range resolution, the height up to 0^0 isoterm will be divided into 50 equal range segments. The average of the reflected power for each range segment is used to compute the reflectivity for the particular range segment. The variation of the reflectivity for the rain period is then plotted against height and the region of high reflectivity will be taken as the height at which rain starts to form, i.e. the rain height. Once the rain height can be calculated, the slant path length for a particular satellite can be determined.

4. Conclusion

The government should recognise the advantages of improving and expanding telecommunications networks as a means of social and economic development of the country especially to the remote areas. One way is by using satellite communication. However, the satellite paths are affected by rain especially when operating in tropical region. Propagation studies in order to determine the rain induced attenuation in tropical region are presented. It is related to the determination of the specific attenuation (dB/km) at a given frequency and earth-space path rain induced attenuation for the satellite communication links. Measurements of macrophysical structure of rain events, especially typical rain cell sizes and distribution of the sizes are also being conducted in order to determine the total attenuation due to rain. It is hoped that from these studies the propagation prediction model of the rain attenuation in tropical region could be developed in order to provide reliable operation for communication satellites operating in tropical regions.

5. Acknowledgement

The author wishes to thank the Research and Consultancy Unit, Universiti Teknologi Malaysia , British Council, Celcom Microwave Sdn. Bhd for supporting the research. The authors also would like to thank the University of Bradford for assisting and advising on the research work.

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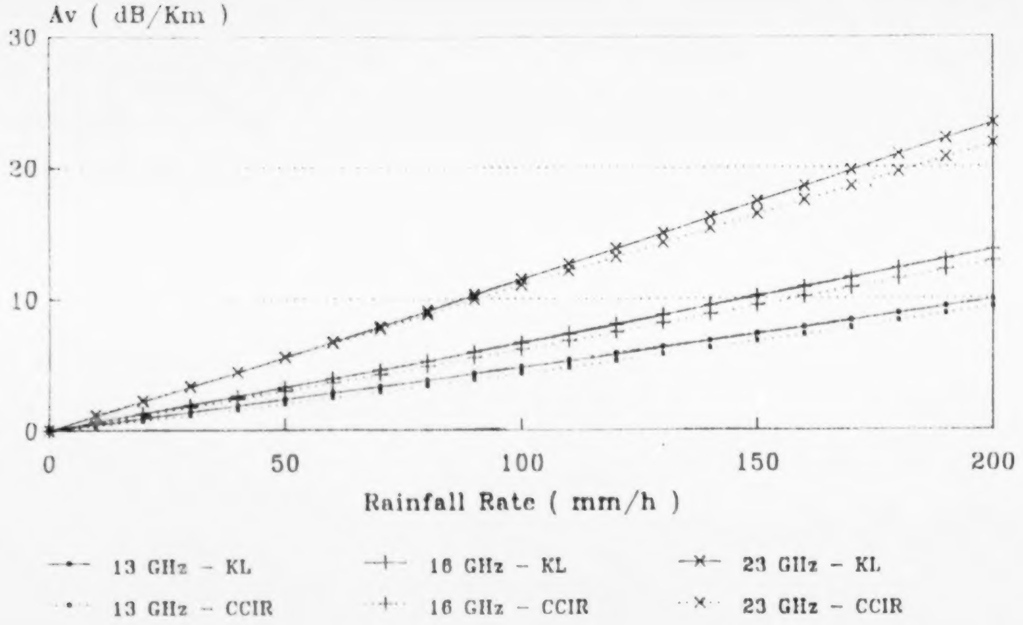
Av (dB/Km)
30
20
10
0
0
50
100
150
200
Rainfall Rate (mm/h)
13 GHz - KL
16 GHz - KL
23 GHz - KL
13 GHz - CCIR
16 GHz - CCIR
23 GHz - CCIR

Fig. 1

IDR OUTER CODEC - *"The BER-Buster"*

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1. ABSTRACT

The Outer Codec is a new technology development that greatly improves achievable performance over a digital satellite link without increasing allocated bandwidth or power requirements in the existing system. The Outer Codec is aimed at providing significant bit-error-ratio (BER) reduction for International Digital Route (IDR) services at information rates ranging from 64 kbps through 45 Mbps. The Outer Codec was developed by COMSAT World Systems (CWS) to be cost-effective and compatible with existing earth station modems that support the IDR service. The Outer Codec, when implemented on a standard INTELSAT IDR link, provides BER performance over the satellite link which is virtually indistinguishable from that of optical fiber cable. Such a significant improvement in quality of service gained through the use of the cost-effective Outer Codec technology could easily stimulate expansion of satellite based international telecommunications.

2. THE INTELSAT IDR SYSTEM

IDR is the premier service offered by INTELSAT, carrying well over 50% of the traffic on the INTELSAT system. The IDR system can support information rates from 64 kbps to 44.736 Mbps, inclusive. While any arbitrary bit rate within this range can be transmitted through the IDR system, the recommended information rates are: 64, 128, 256, 384, 512, 1024, 1544, 2048, 6312, 8448, 32064, 34368, and 44736 kbps, which are based on International Telecommunications Union (ITU) ISDN and ITU hierarchical rates [1]. Therefore, not only does the IDR system provide flexibility for channel symbol rate selection, but also, the modems designed for IDR operation can be used for signaling at various symbol rates.

Digital data in the presently installed IDR system are encoded by a punctured convolutional code of rate 3/4 (33.33% redundancy), and QPSK modulated using differential encoding and coherent demodulation. The IDR system has been designed to achieve a BER of $1x10^{-7}$ under clear sky conditions, which is appropriate for satisfactory performance of voice traffic. However, other digital services, including voiceband data traffic and the ubiquitous Group 3 facsimile service, which are increasing rapidly on the INTELSAT system, require improved end-to-end BER performance for satisfactory operation. Recently, CWS customers, as well as COMSAT Laboratories, have analyzed a number of digital circuit multiplication equipment (DCME) schemes through computer simulation and hardware measurements that clearly demonstrate, and quantify, the need for improved IDR link performance [2]. In direct response to these customer concerns regarding the insufficient performance over currently available IDR satellite circuits, the Outer Codec was developed by CWS.

3. BACKGROUND

An investigation into the specific IDR performance shortfalls and potential technical solutions resulted in identification of several possible methods to improve the performance of the IDR service without making drastic modifications to the existing system. Most of the candidate solutions were based on more powerful forward error correction (FEC) techniques. One solution that did not involve an FEC technique was derived by observing that the BER performance of the IDR system improves by more than one order of magnitude as the E_b/N_o is increased by one dB. Therefore, a clear-sky BER of $1x10^{-9}$ could be achieved by increasing the E_b/N_o by 2 dB. However, because of limitations on power, and antenna sizes at the earth stations and satellite transponders, increasing the E_b/N_o could involve substantial decrease in the number of carriers per transponder, or considerable reductions in the system throughput.

The alternative FEC solutions centered around a bandwidth- and power-efficient technique known as concatenated coding which could achieve a very low BER over the IDR channel. In such a system, an additional level of FEC processing is applied to the information stream to transform the IDR service into a concatenated coded system. The present rate 3/4 convolutional code, and its derivatives, were considered for use as the inner code, reducing the high BER of the transmission channel to a medium BER. Considering the burst error statistics of the present IDR channel, high rate Reed-Solomon (RS) codes were selected for the outer code to further reduce the clear-sky BER to $1x10^{-9}$ or less [3]. The concatenated code method selected for implementation built entirely upon the existing IDR system design and greatly enhanced its performance.

In particular, as Figure 1 illustrates, a high rate, algebraic Reed-Solomon (RS) block code, with parameters designed to combat residual errors from the inner convolutional code, was added to the rate 3/4 convolutional code with QPSK modulation employed by the present IDR system. The RS code parameters vary over the range of operating information rates, as shown in Table 1, to ensure backward compatibility with existing modem designs. At the primary rate and above, each of the specified RS codes adds about 9% redundancy to the transmit data stream. No changes were made to the QPSK modem design to compensate for the increase in intersymbol interference (ISI) and adjacent channel interference (ACI) caused by the increased channel symbol rate. Not only was it more economical to use the present modems and filters, it was analytically and experimentally determined that the extra system degradation due to the ISI and ACI increase was negligible, less than 0.2 dB. Overall implementation of the Outer Codec resulted in a very effective, non-interfering, inexpensive technology add-on that can be easily installed by earth station operators to realize performance improvements which range from a thousand to more than a million times better than those measured with existing IDR systems.

4. TECHNOLOGY

State-of-the-art digital technology was brought to bear to implement the Outer Codec prototype model hardware at COMSAT Laboratories. Although the concept of concatenated coding has been well known in coding literature for many years [4], implementation of RS codecs has only recently become commercially practical with the advent of single integrated circuit RS code processors [5]. One of these newly available high speed dedicated RS processors was interfaced with a sophisticated, but inexpensive, digital signal processor (DSP) device. The required interleaving, scrambling, synchronization, data handling, and device interface algorithms were all achieved in firmware executed by the DSP microprocessor and its supporting memory. Not only does a firmware-based design minimize the recurring cost of the product, it also makes it very flexible. Numerous RS codes and data processing algorithms were experimented with during the early design and development stages. Additionally, the same basic hardware design can be reprogrammed to support several standard IDR information rates, within the clocking speed limitations of the microprocessor devices.

Info Rate (kbps)	RS Code (n,k,t)	BW Exp.	Max RS delay, ms
64	(126,112,7)	0.125	115
128	(126,112,7)	0.125	58
256	(126,112,7)	0.125	29
384	(126,112,7)	0.125	19
512	(126,112,7)	0.125	15
1024	(126,112,7)	0.125	8
1544	(225,205,10)	0.0976	9
2048	(219,201,9)	0.0896	7
6312	(194,178,8)	0.0899	2
8448	(194,178,8)	0.0899	< 2
32064	(208,192,8)	0.0833	< 2
34368	(208,192,8)	0.0833	< 2
44736	(208,192,8)	0.0833	< 2

TABLE 1. REED-SOLOMON CODES FOR IDR

A unique algorithm which provided simultaneous synchronization of the deinterleaver, outer decoder, descrambler, and interface functions was conceived by COMSAT Laboratories. The concept greatly minimized

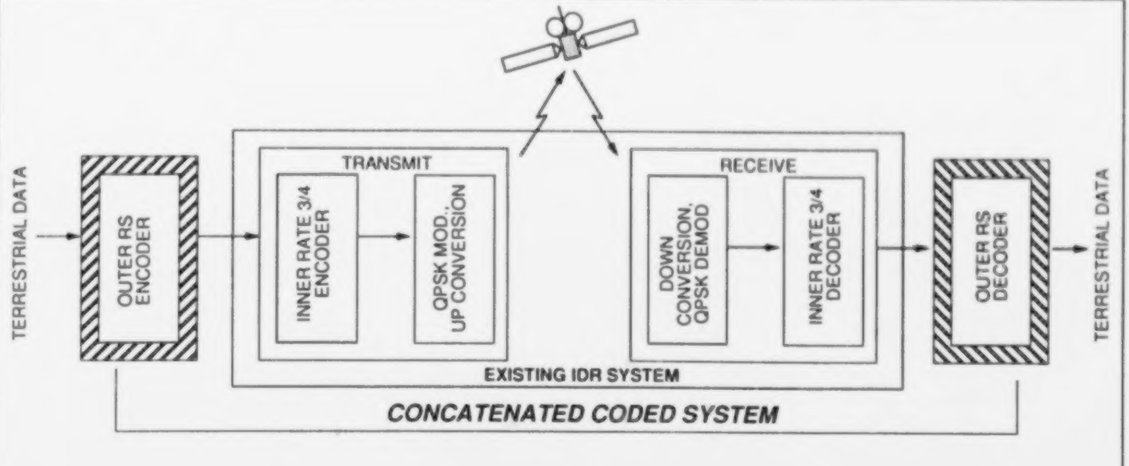

FIGURE 1. SYSTEM BLOCK DIAGRAM

the hardware complexity and cost, while simplifying the overall timing requirements of the Outer Codec implementation. Invention rights to this unique algorithm were waived by COMSAT in the process toward international standardization of the Outer Codec concept.

The prototype Outer Codec was developed as a single printed circuit board which is able to interface directly with several commercial IDR modems. All of the Outer Codec design principles were made publicly available on an international basis so that IDR modem manufacturers worldwide could utilize the same concept in developing retrofit kits for existing modem designs, or in adding outer coding to newly released IDR modem designs. As the Outer Codec design information is equally available to all countries, manufacturers in developing countries may choose to consider manufacturing their own Outer Codecs. To date, most major IDR modem manufacturers have availed themselves of the COMSAT technology, and are at various stages in developing, manufacturing, and selling their own version of the Outer Codec.

5. STANDARDS

Once the Outer Codec concept was sufficiently proven, COMSAT launched a campaign to incorporate the concept, in its entirety, in the internationally recognized INTELSAT Earth Station Standards (IESS). INTELSAT conducted independent tests of the COMSAT prototype equipment in their Technical Laboratories which verified the performance results measured by COMSAT. INTELSAT engineers also studied the detailed COMSAT design, and made a valuable contribution toward refining the interleaving algorithm, which significantly reduced the overall processing delay.

A joint effort was undertaken by COMSAT and INTELSAT to produce an Appendix for IESS-308 which completely specified the Outer Codec technical requirements. The specification was adopted by the INTELSAT Technical Advisory Committee in the Fall of 1992 as an optional Appendix to IESS-308, making it possible for IDR users, through bilateral agreement, to implement Outer Coding on their IDR carriers, thus improving the quality of the service realized by at least 1000-fold. Several major IDR users of the INTELSAT system have plans to implement the IDR Outer Codec on numerous satellite links before year-end 1993.

6. TEST PROGRAM

To determine the actual performance improvement gained from the Outer Codec technology, an extensive test program was conducted both in laboratory and field environments. The Outer Codec BER performance capability was measured on the satellite simulator facility at COMSAT Laboratories which models such impairments as downlink noise, uplink ACI, and downlink CCI. The IDR carrier with outer coding was compared with an IDR modem operating in the same transmission environment, but without outer coding. All theoretically predicted performance improvements were met by the

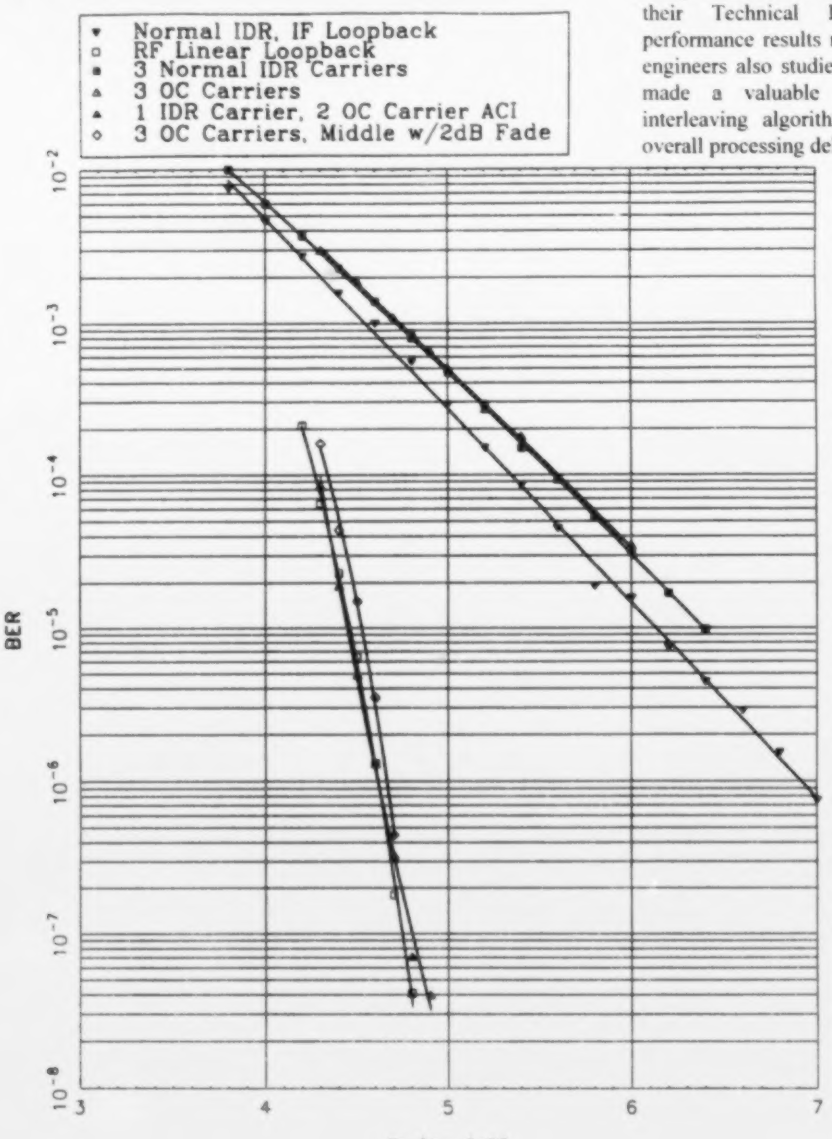

FIGURE 2. LABORATORY ACI MEASUREMENTS

COMSAT Outer Codec prototype implementation.

An example test result, Figure 2 illustrates ACI performance measured with three carriers on a 36 MHz transponder. For each test, the carriers were set at equal power levels with a carrier-to-intermod ratio of 17 dB, and a transponder input backoff set at 10 dB. The channel spacing was established at 2.0025 MHz, which is the allocation for E1 IDR carriers without outer coding. No measurable degradation over the baseline performance curve for RF linear loopback is observed for the case where the desired carrier is degraded by two equal level IDR carriers with outer coding. Of even greater significance is that there is also no noticeable degradation for the IDR carrier without outer coding when it is subject to two adjacent carriers with outer coding. Figure 2 also shows the minimal performance degradation of about 0.1 dB incurred when an outer coded IDR carrier is subject to interference from two outer coded IDR carriers, while undergoing a 2 dB fade. From an absolute performance improvement standpoint, it can be observed that, at a BER of 1×10^{-6}, the Outer Codec exhibits slightly more than 2 dB improvement in required E_b/N_o over the IDR carrier without outer coding. Similar results were obtained for other test configurations which included full transponder testing and testing in the presence of CCI [6].

The Outer Codec also performed exceptionally well in a U.S. - to - U.K. transatlantic field test. In the absence of "events" during the test, and given the now prevalent IDR margins, both reference and test carriers ran error-free for many hours The Outer Codec demonstrated its strength during actual conditions of severe rain fade in the field. Figure 3 shows a 24 hour period of heavy, but steady rain where the reference carrier exhibited an observable BER, while the carrier with outer coding maintained error-free performance. Figure 4 illustrates another 24-hour period of the test where the test procedure was modified to run with lower e.i.r.p. giving lower E_b/N_o to attain more significant BER on the reference carrier while the outer coded test carrier still continued to run error-free. At the ten thousand second mark in Figure 4, both carriers exhibited a momentary sync loss which was attributed to external interference. The field test established that the Outer Codec contributed no unforeseen or detrimental interaction with other carriers, or with normal space or ground segment subsystems. Additionally, the performance of the Outer Codec, as measured in the field, was in agreement with the laboratory predictions and measurements [7].

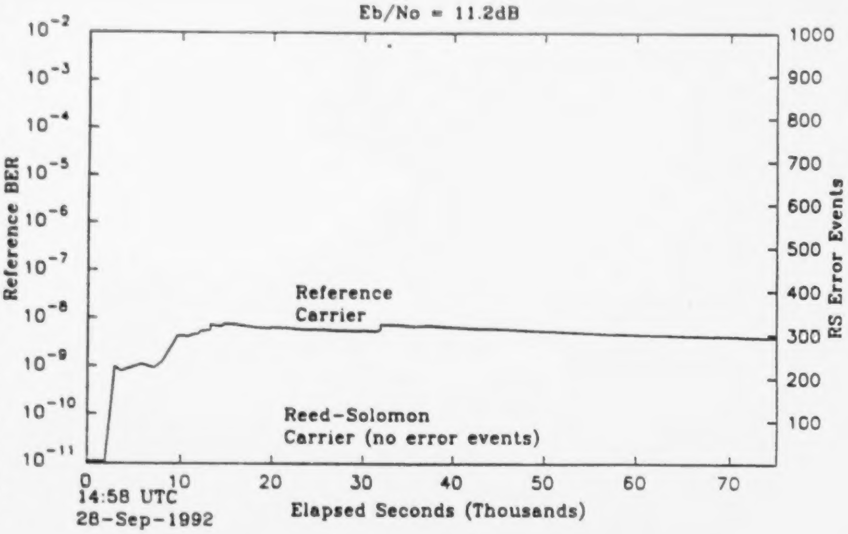

Figure 3. Transatlantic Field Test Result

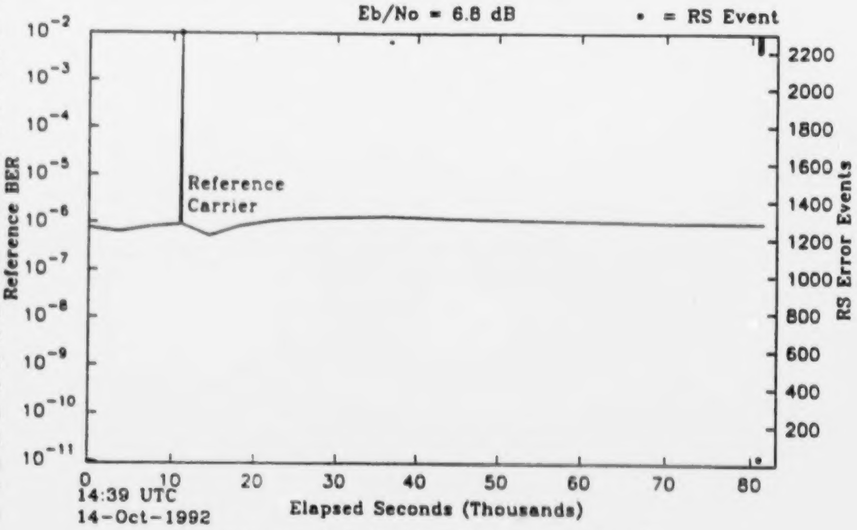

Figure 4. Translantic Field Test Result

More recently field tests were carried out between the U.S. and some emerging countries. Specifically, transoceanic field tests were conducted between the U.S. and Guatemala on INTELSAT 513 at 307 E, and between the U.S. and Thailand on INTELSAT 510 at 174 E. Thailand had been very interested in conducting an Outer Codec field test to determine if the Outer Codec could substantially improve the quality of service of its digital satellite telecommunications given the fact that the Siracha earth station operates in a severely degraded satellite link environment largely due to a low look angle to the satellite coupled with an extremely long annual monsoon season. To facilitate the Thailand field test, CWS provided significant engineering, equipment, and management assistance to the Communications Authority of Thailand. Figure 5 illustrates about a thousand-fold improvement in the BER observed during a one-week test period between the reference and test carriers. It is envisioned that these long-term tests will be the final precursor to in-service installation of the newly-available commercial modems with RS Outer Coding.

As manufacturers are now completing initial equipment designs which implement Outer Coding, COMSAT has assisted several of them with interoperability testing activities. During interoperability tests, a COMSAT-developed RS Outer Codec unit is interfaced with newly developed equipment to determine if the new algorithm implementations, designed from the specification in IESS-308 Appendix F are, in fact, equivalent. No significant incompatibilities have been uncovered thus far.

7. FUTURE BENEFITS

As mentioned above, several large IDR modem manufacturers have already produced hardware designs which implement the Outer Codec; even more are known to have undertaken initial design and development activities. Numerous inquiries have been received from the IDR users community concerning operation of IDR service with Outer Coding. As the manufacturers' new designs become commercially available, interested users will be able to implement the technology, and the demand for Outer Coding will undoubtedly grow as the benefits of significant performance improvement are reaped with minimal user expenditure and without additional power or bandwidth consumption.

In the near future, the Outer Codec is likely to find significant use for transmission of services, other than voice or G3 fax, that require excellent performance, including voiceband data, higher speed data, videotelephony, and future services using the ATM layer.

Acknowledgments

The author wishes to acknowledge her coworkers who were significantly involved in the detailed development of the COMSAT Outer Codec, including: Mr. Peter N. Johnson and Dr. Farhad Hemmati of COMSAT Laboratories, and Mr. Calvin B. Cotner of COMSAT World Systems.

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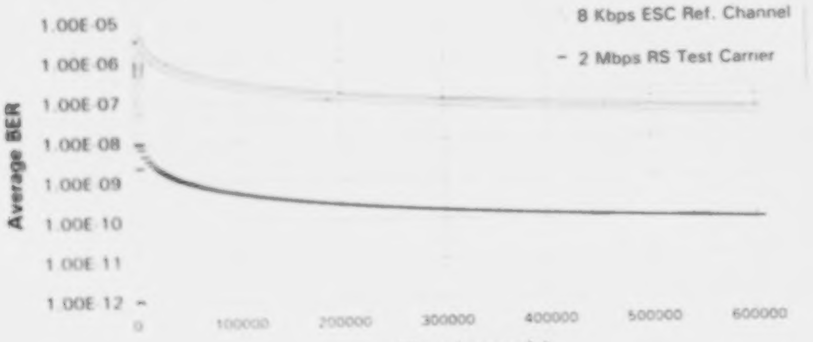

FIGURE 5. Thailand to U.S. - Average BER (Aug. 2 - 9, 1993)

An Economical and Reliable Satellite Communication System
Linking Remote Islands and A Main Island

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1. ABSTRACT

This paper introduces an advanced satellite communication system linking remote islands and a main island, called DYANET(C) (DYnamic channel Assigning and routing satellite aided digital NETworks (C)). DYANET(C) is based on DYANET and offers two additional functions, that is to provide the satellite channels for transit switches that adopt a channel associated signaling system and for leased circuit servises. To realize these functions, new network control technologies and new equipments have been developed.

INTRODUCTION

In Japan, NTT (Nippon Telegraph and Telephone Corporation) developed DYANET (DYnamic channel Assigning and routing satellite aided digital NEtworks).[1][2][3] DYANET has been in commercial use since October 1988. It uses satellite communication to provide trunk circuits economically in combination with terrestrial circuits by means of "common alternative routing". DYANET carries overflow traffic among transit switches in a Common Channel Signaling System (CCS) through common satellite channels on a demand assignment basis. This makes good use of satellite communication's advantages; wide coverage of service area and flexible connection. Therefore, DYANET represents a change in the general idea of how satellite communications are used. It makes it possible to get the flexible network economically.

In February 1991, NTT put the ISDN-compatible DYANET II[4] into commercial use. With DYANET II, remote ISDN subscribers can be economically and rapidly accommodated on demands. This system is also available for temporary and emergency use. DYANET series have become very important in the domestic network.

On the other hand, satellite channels are used in the remote island routes where the extending the terrestrial circuits is costly compare with the satellite channels. However, conventional satellite systems cannot offer enough economical, reliable and flexible satellite channels. For this reason, a new DYANET-like satellite communication system is required to harmonize satellite communication and terrestrial communication systems and to provide the fundamental means for supplying the various kinds of services as economically as possible. DYANET(C) which developed in 1992 has been in commercial use since February 1993, was designed and built for this purpose.

Each system in the DYANET series adopts a different radio frequency band and a radio communication system according to their respective purposes. In the near future, the DYANET series will be integrated into a universal satellite communication system called DYANET-X for greater versatility.

3. SYSTEM CONCEPT

3.1 SYSTEM CONCEPT THROUGH DYANET SERIES

Figure 1 shows DYANET series network structure. The common concept of these systems is based on the features of satellite communications: traffic concentration by using its multiple access capability and wide-area coverage. Namely, dispersed, light and largely fluctuating traffic, such as overflow from terrestrial circuits and calls to/from isolated subscribers, is transmitted efficiently through satellite channels.

Usually, in a trunk circuit, the traffic is concentrated by transit switches. So, using satellite communication for point-to-point transmission, does not make full use of its advantages.

Suppose that the trunk circuits are divided into two groups: one where traffic fluctuation is small and another where it is large. For this, the transit switch selects the second group of circuits, when the first group's capacity is exceeded. In this case, Satellite communication is advantageous for the second group, and economical network can be realized by using terrestrial circuits for the first group and satellite circuits for the second , as shown in Fig.2. At the same time, a network comprising satellite and terrestrial channels enhances reliability because chances of some kinds of breakdown can be minimized. (e.g. natural disaster disrupting terrestrial lines).

In such a system, the satellite network is used as an alternative route for excess traffic in each terrestrial trunk line. This is what we call a "common alternative routing system".

3.2 REQUIREMENT OF A REMOTE ISLAND USE FOR SATELLITE COMMUNICATION

SC-20 and SC-30[illegible] are the two satellite communication systems NTT is using for transmissions between Japan's remote islands and its four main islands. These systems have some following weak points.

(1) They use satellite channels based on a pre-assignment technology. Therefore, satellite channels are scarcely fully occupied and it is a costly medium.
(2) Each system uses one satellite. In the case of SC-20, it is CS-3a. Considering a satellite breakdown, it takes a long time to recover by means of using another satellite.
(3) SC-20 cannot accommodate many traffic earth stations. This means only a few of remote islands

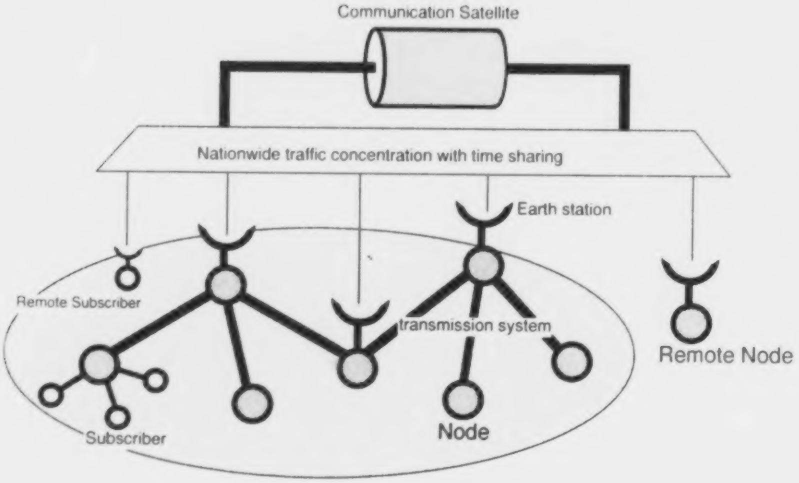
Communication Satellite
Nationwide traffic concentration with time sharing
Earth station
Remote Subscriber
transmission system
Remote Node
Subscriber
Node

Fig.1 DYANET SERIES NETWORK STRUCTURE

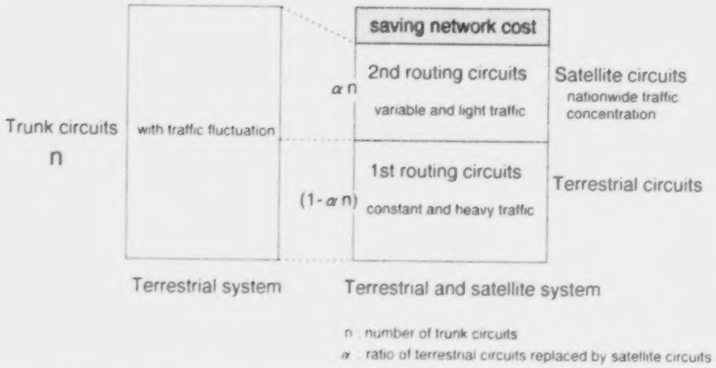
saving network cost
Trunk circuits
n
with traffic fluctuation
αn
2nd routing circuits
variable and light traffic
Satellite circuits
nationwide traffic concentration
(1-αn)
1st routing circuits
constant and heavy traffic
Terrestrial circuits
Terrestrial system
Terrestrial and satellite system
n : number of trunk circuits
α : ratio of terrestrial circuits replaced by satellite circuits

Fig.2 REQUIRED TRUNK CIRCUITS USING BOTH SATELLITE AND TERRESTRIAL SYSTEMS

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can be connected with a main island. And SC-30 can provided only a few satellite channels per traffic earth station.

Hence, the following items are required on most remote islands.

(i) Low Cost
(ii) Higher Reliability
(iii) Increasing Traffic Capacity

3.3 SYSTEM CONCEPT OF DYANET(C)

According to two requirements for remote islands, low cost and increasing traffic capacity, DYANET-like satellite system is desired. Therefore, DYANET(C) has been designed in an advanced satellite communication system linking remote islands and a main island. For granting the remain requirement, higher reliability, this system has a duplicated system configuration using two communication satellites. Namely, for public switched telecommunication services, half the communication traffic capacity can be maintained if one satellite breaks down. For leased circuit services, the leased circuits offered though the failed satellite can be automatically reestablished through the other satellite.

In Japan, satellite communication systems serve remote islands island with C band (6/4GHz) and DYANET(C) also adopt C band. DYANET is offered with Ka band (30/20GHz) at the main island. Therefore, DYANET(C) and DYANET can not be mutually connected. However, these systems will be able to be connected mutually in the NTT's universal satellite communication system of the future. For ensuring this, DYANET(C) has to adopt as many common technologies in DYANET series as possible.

By the way, Remote islands are located far from a main island, the cost of submarine-cable construction cannot be justified by the light traffic. Therefore, satellite channels are principal media connecting a main island. This is clearly different from DYANET. DYANET(C) offers two additional features which DYANET does not. One is satellite channels used in trunk circuits for transit switches that adopt a channel associated signaling system. The other is satellite channels for leased circuit services.

4. SYSTEM CONFIGURATION

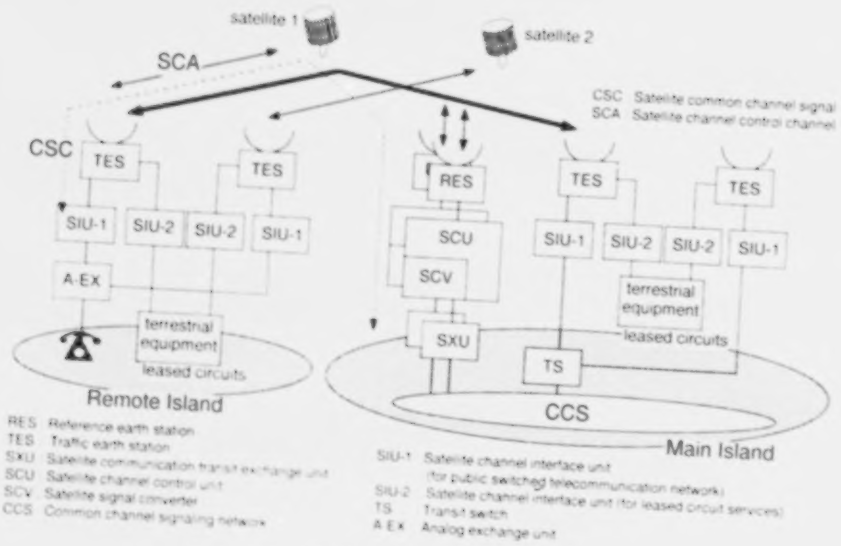
4.1 BASIC TECHNOLOGIES OF DYANET(C)

DYANET(C) uses the common technologies which DYANET uses, demand assignment (DA), farthest-end-routing and transponder hopping.

Demand assignment technology is effective in concentrating light traffic dispersed over wide area. This means that the required number of trunk circuits can be reduced in the same blocking rate of terrestrial network.

Farthest-end-routing technology is available to prevent incomplete calls due to double-hop connections.

Transponder hopping technology, a kind of frequency hopping, makes a TDMA system access any of transponders. It has been adopted to to ensure connectivity among traffic earth stations.



satellite 1
satellite 2
SCA
CSC
CSC Satellite common channel signal
SCA Satellite channel control channel
TES
TES
RES
TES
TES
SIU-1
SIU-2
SIU-2
SIU-1
SCU
SCV
SIU-1
SIU-2
SIU-2
SIU-1
A-EX
terrestrial equipment
terrestrial equipment
leased circuits
SXU
TS
leased circuits
Remote Island
CCS
Main Island
RES Reference earth station
TES Traffic earth station
SXU Satellite communication transit exchange unit
SCU Satellite channel control unit
SCV Satellite signal converter
CCS Common channel signaling network
SIU-1 Satellite channel interface unit (for public switched telecommunication network)
SIU-2 Satellite channel interface unit (for leased circuit services)
TS Transit switch
A-Ex Analog exchange unit

Fig.3 SYSTEM CONFIGURATION OF DYANET(C)

Table.1 MAJOR SYSTEM PARAMETERS OF DYANET(C)

Communication Satellite	CS-3a and 3b (Launched in 1988)
Access Scheme	Transponder hopping demand assignment TDMA
Maximum Traffic Capacity	
Traffic per satellite	960 erl / CS-3a and 3b (MAX 6 transponders)
Traffic per TES	320erl / TES
Terrestrial Network Interface	
Traffic (TES)	8.192 Mbit / s × 3 (360 channels)
SIU-1	MAX 8.192 Mbit / s × 3
SIU-2	MAX 8.192 Mbit / s × 2
Signaling (TS-TES)	Common channel signaling system No. 7 ISUP
Earth Station	MAX 210 Earth Stations (60 Earth Stations / transponder)
Antenna	Dual beam antenna (5.5m in diameter)
Transmitter	100W output with SSPA
Frequency	6 / 4 GHz (C band)
MODEM and FEC	QPSK coherent demodulation with R = 1 / 2 , K = 4 Convolutional encoding-Viterbi decoding
TDMA clock rate	25.024 MHz (information rate : 20.48 Mbit/s)

4.2 FUNCTION OF DYANET(C)

The system configuration of DYANET(C) is shown in Fig.3. DYANET and DYANET(C) consists of the following common units: communication satellites (using C band in DYANET(C)), reference earth station (RES), traffic earth stations (TESs), satellite channel control unit (SCU), satellite communication transit exchange unit (SXU) and transit switches (TSs). TSs, analog exchange unit (A-EX) and terrestrial equipments are already used in the terrestrial circuits. To provide a satellite channel for the PSTN services on a demand assignment basis, SXU needs to receive demand with call control information from the transit switches. In DYANET, SXU can receive it through a common channel signaling system (CCS). However, analog exchange units are not connected to SXU through any communication links. Therefore, SIU-1 was newly developed to connect analog exchange units to SXU. SIU-1 has the functions of converting the protocols of the call control signals from/to the channel associated signaling format to/from the common channel signaling format, and transmitting the converted call control signals to SXU/analog exchange units through a satellite common signaling channel (CSC).

On the other hand, to provide a satellite channel for the leased circuits services on a demand assignment basis, SCU needs to receive demand with control information from any units. In the leased circuits services system, however there are no units to supervise the circuits and send the setup/release requests to SCU on a demand assignment basis. So SIU-2 was newly developed to do that and to transmit these signals through CSC.

The main system parameters are listed in Table 1.

4.3 RADIO SYSTEMS

As for a radio system, DYANET(C) meets the requirements for remote islands described in chapter 3 by using C band radio frequency (6/4 GHz) and a three-reflector-type double-torus dual-beam antenna. With C band radio frequency, there is little attenuation from heavy rain and it can cover a wide area. Therefore, DYANET(C) can accommodate many TESs on scattered remote islands. The three-reflector-type double-torus dual-beam antenna enables the TES to access two satellites simultaneously. This antenna enhances network reliability and avoids all satellite channel disconnection even if one of the satellites becomes inoperable due to a sun transit and so on.

5. NETWORK CONTROL SYSTEM OF DYANET(C)

5.1 FARTHEST-END-ROUTING CONTROL

In a public switched telecommunication network, connections are established link-by-link by each switching node. Therefore, there is the possibility that a multiple hop connection of satellite channels will occur if switching nodes request satellite channels independently. To avoid a multiple hop connection of satellite channels and to efficiently use satellite channels, DYANET(C) adopts "farthest-end-routing" control, which selects a direct route to the TES farthest from the originating TS, that is, to the TES

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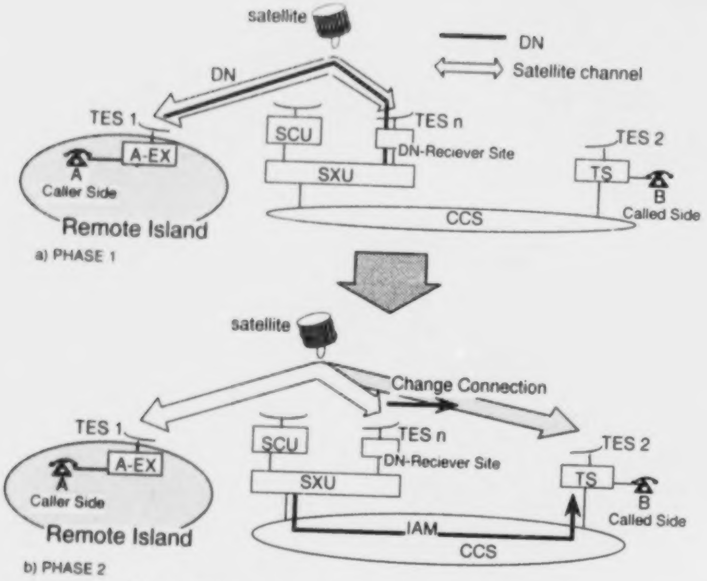

Fig.4 CHANGE CONNECTION CONTROL CONCEPT

nearest the terminating subscriber.

Mainly, SXU performs this network control. When a originating TS requests satellite channels to SXU, SXU translates the destination number, seeks a terminating TS, and chooses a TES that has a vacant channel.

5.2 CHANGE CONNECTION CONTROL

Figure 4 shows the "change connection control" concept. DYANET(C) accommodates analog exchange units with a channel associated signaling system. To decide a terminating TS, SXU must receive a destination number (DN) through a speech channel. For this, SXU requests the satellite channel to SCU between the originating TES (TES 1) and the pre decided TES (TES n) connected to SXU. And then sends a "change connection" signal for the speech channel between the originating and terminating subscriber. This signal indicates these meanings, to release the connection between the originating TES (TES 1) and the pre decided TES (TES n) and to setup the connection between the originating TES (TES 1) and the terminating TES (TES 2).

5.3 NETWORK CONTROL FOR PUBLIC SWITCHED TELECOMMUNICATION NETWORK (PSTN)

Figure 5 shows the network control procedure for the analog exchange with channel associated signaling system. With an analog exchange unit, the destination number is transmitted through the speech channel. Consider the case when subscriber A on a remote island calls subscriber B on a main island.

(1) The originating analog exchange unit (A-EX 1) selects the outgoing channel, transmits a seizing signal indicating the use of the channel.
(2) SIU-1 detects and convert the signal and transmit it to SXU through CSC.
(3) When SXU receives this signal, converted by SIU-1, SXU requests the satellite channel setup to SCU for receiving a destination number (DN) from the analog exchange unit.
(4) SCU hunts a satellite channel between the originating TES (TES 1) on the remote island and a pre decided TES (TES n) on the main island, and orders two TESs (TES 1 and TES n) to establish the connection (CH 1). The pre decided TES (TES n), as the DN-receiving TES, is always connected to SXU by dedicated lines.
(5) SXU sends a signal showing readiness to A-EX 1 through CSC. After that, SXU receives the DN.
(6) SXU translates the DN and selects the outgoing route (TES 2) with "farthest-end-routing". Then SXU sends the "change connection" request to SCU.
(7) According to the indication of SXU, SCU orders TES n to release the connection (CH 1) and TES 1 and TES 2 to newly establish the connection (CH 2). At the same time, SXU sends an IAM (initial address message) to the transit switch connected to TES 2.
(8) After that, the call control sequence proceeds based on the CCS No.7 ISDN user part.

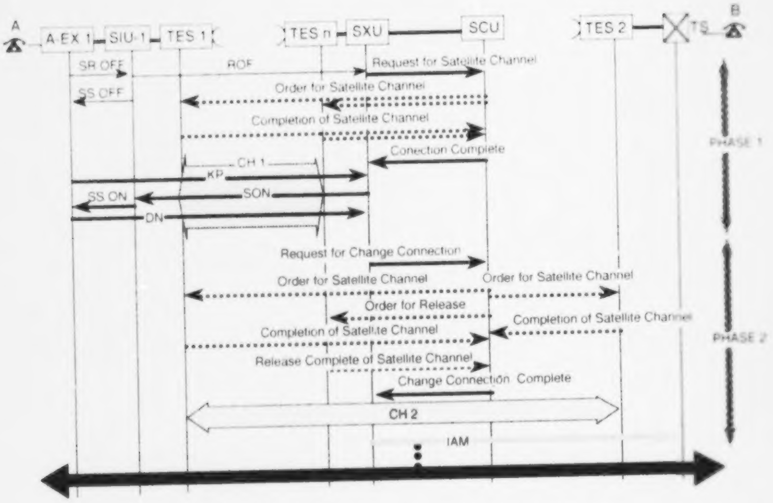
A
A-EX 1
SIU-1
TES 1
TES n
SXU
SCU
TES 2
TS
B
SR OFF
ROF
Request for Satellite Channel
SS OFF
Order for Satellite Channel
Completion of Satellite Channel
Conection Complete
CH 1
KP
SS ON
SON
DN
PHASE 1
Request for Change Connection
Order for Satellite Channel
Order for Satellite Channel
Order for Release
Completion of Satellite Channel
Completion of Satellite Channel
Release Complete of Satellite Channel
Change Connection Complete
CH 2
IAM
PHASE 2

Fig.5 CALL CONTROL PROCEDURE FOR PSIN

5.4 NETWORK CONTROL FOR LEASED CIRCUITS

In terrestrial, leased circuit system has a duplicated system configuration, that is, each leased circuit has two transmission routes, one is active and the other is stand-by. DYANET(C) should keep the equivalent quality to terrestrial one. Therefore, two satellite channels are needed for two route. Figure 6 shows the duplicated system configuration in DYANET(C). However, setting up the two satellite channels for one leased circuit is not good for effective use of satellite channels. In this system, only an active route is set up at the normal operation, and a stand-by route is set up while an active route is inoperable. Figure 7 and 8 show the network control procedure for the leased circuits. Consider the case when transmission equipment detects the transmission line alarms on an active route.

(1) One route is already in use (active route). When an active route breaks down, at least one piece of terrestrial equipment detects transmission line alarms.
(2) The terrestrial equipment sends a alarm to the SIU-2 3 in a stand-by system.
(3) Then, SIU-2 3 sends a request for satellite channel to SCU 2 through CSC.
(4) SCU 2 identifies the TESs (TES 3 and TES 4) connected to each SIU-2 (SIU-2 3, SIU-2 4). SCU 2 orders for satellite channel between the TESs (TES 3 and TES 4).
(5) The TESs (TES 3 and TES 4) send the completed signals of satellite channel connection to the SCU 2.
(6) Judging the satellite channel quality whether the channel is error free, SIU-2 3 and SIU-2 4 notify the completion of the satellite channel connection.
(7) When the satellite channel between TES 1 and TES 2 is recovered, SIU-2 3 and SIU-2 4 release the satellite channel between TES 3 and TES 4 by similar procedure from (1) to (5).

6. CONCLUSION

This paper described how DYANET(C) offers economical and reliable satellite communications linking remote islands and a main island. As DYANET(C) increases the traffic capacity and the number of accommodating earth stations, it is able to rapidly meet a demands.

The remain restriction with DYANET(C) is that a TES on a main island cannot be positioned freely because of frequency interference from other systems such as microwave systems. Therefore, DYANET uses Ka band. For this reason, it is regrettable double-hop connections have not been entirely eliminated.

NTT will launch two communication satellites called N-STARs in 1995. They have cross strap transponders like the ones in INTELSAT. These transponders can interconnect among Ka band, Ku band, C band. NTT is now developing a future satellite system (DYANET-X) using N-STARs. This next system integrates the DYANET series, and solves the above mentioned double-hop connection.

7. ACKNOWLEDGEMENT

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of NTT Radio System Laboratories for their guidance and useful suggestions. The authors also thank Mr. T. Masamura, Manager, and the participants in the development of DYANET(C) for their valuable contributions.

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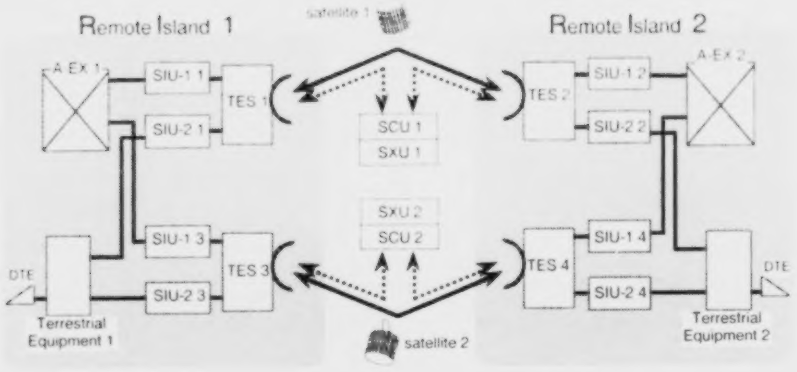
Remote Island 1
satellite 1
Remote Island 2
A-Ex 1
SIU-1 1
TES 1
SIU-2 1
SCU 1
SXU 1
TES 2
SIU-1 2
SIU-2 2
A-Ex 2
SXU 2
SCU 2
SIU-1 3
TES 3
SIU-2 3
DTE
Terrestrial Equipment 1
TES 4
SIU-1 4
SIU-2 4
DTE
Terrestrial Equipment 2
satellite 2

TES : Traffic earth station
SXU : Satellite communication transit exchange unit
SCU : Satellite channel control unit
A-EX : Analog exchange unit
SIU-1 : Satellite channel interface unit (for public switched telecommunication network)
SIU-2 : Satellite channel interface unit (for leased circuit services)

Fig.6 DUPLICATED SYSTEM CONFIGURATION

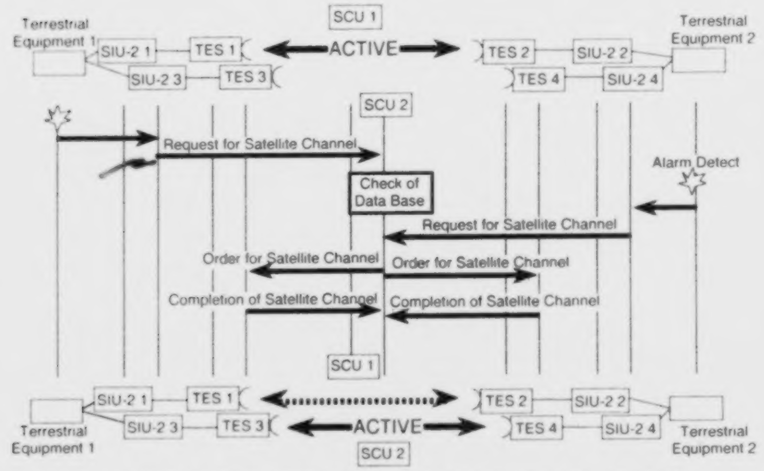
SCU 1
Terrestrial Equipment 1
SIU-2 1
TES 1
ACTIVE
TES 2
SIU-2 2
Terrestrial Equipment 2
SIU-2 3
TES 3
TES 4
SIU-2 4
SCU 2
Request for Satellite Channel
Alarm Detect
Check of Data Base
Request for Satellite Channel
Order for Satellite Channel
Order for Satellite Channel
Completion of Satellite Channel
Completion of Satellite Channel
SCU 1
SIU-2 1
TES 1
TES 2
SIU-2 2
Terrestrial Equipment 1
SIU-2 3
TES 3
ACTIVE
TES 4
SIU-2 4
Terrestrial Equipment 2
SCU 2

Fig.7 NETWORK CONTROL PROCEDURE FOR A LEASED CIRCUIT (SETUP)

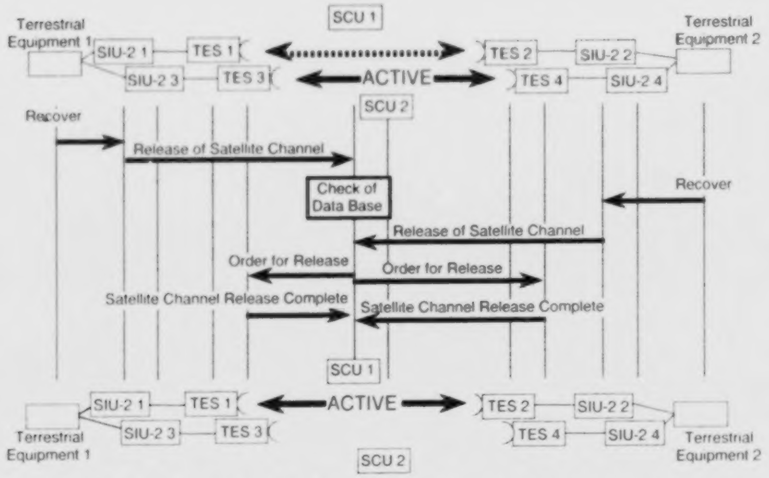
SCU 1
Terrestrial Equipment 1
SIU-2 1
TES 1
TES 2
SIU-2 2
Terrestrial Equipment 2
SIU-2 3
TES 3
ACTIVE
TES 4
SIU-2 4
SCU 2
Recover
Release of Satellite Channel
Check of Data Base
Recover
Release of Satellite Channel
Order for Release
Order for Release
Satellite Channel Release Complete
Satellite Channel Release Complete
SCU 1
SIU-2 1
TES 1
ACTIVE
TES 2
SIU-2 2
Terrestrial Equipment 1
SIU-2 3
TES 3
TES 4
SIU-2 4
Terrestrial Equipment 2
SCU 2

Fig.8 NETWORK CONTROL PROCEDURE FOR A LEASED CIRCUIT (RELEASE)

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Operator and Information Services
for
Developing Countries Telecommunications Networks

George J. Lissandrello
President, Columbia Communications Corporation
Honolulu, Hawaii, U.S.A.

1. ABSTRACT

In order for developing countries to economically enhance and expand their existing telecommunications networks and services, new and innovative approaches are required. This is true for operator and information services which are provided by the telecommunications carriers. Technologies and systems architectures are available today to allow for the implementation of such services on networks based upon past, present and future central office switching systems.

2. INTRODUCTION

2.1 OVERVIEW

This paper covers the technology and architecture which is available to allow telecommunications carriers to implement standard and enhanced operator and information services through existing hardware and software on past, present and future central office switching systems. Applications such as Directory Assistance, Toll Ticketing, Enhanced 911 emergency and Property Management systems are reviewed. Examples of existing systems will be described including those used in satellite based international gateway systems, island nations, independent U.S. telcos and interexchange (long distance) carriers.

The unique requirements for the implementation of operator/information services of the developing countries are addressed including a number of suggested alternatives to meet those requirements. In addition, methods of implementation are reviewed including strategic relationships and technology transfer.

Suggestions as to how developing countries can economically implement operating and information services are made and conclusions drawn.

2.2 THE 1990'S ENVIRONMENT

The telecommunications environment of the 1990's finds the telecommunications carriers of developing countries trying to reposition themselves to adapt to new network, hardware and software platforms. These entities must address the following elements which make up the new environment:

- the deregulation and denationalization of the telecommunications networks, service providers and manufacturers which allows for the creation of competition and new business opportunities.

- the availability of new technologies, networks and information services which shorten the life cycle of systems and create new opportunities for those carriers that can optimize on these new offerings.

- the exponential growth in the outsourcing and systems integration business gives new opportunities to the telecommunications carriers allowing them to expand into new international and industry markets.

- the requirement to learn to manage the new technologies, systems and services as applied to meet the carriers customer's applications needs.

- the need to interconnect a variety of new and existing telecommunication networks, terminals and communication based information systems of different vintages, standards and manufacturers.

- the need to adapt existing systems to new platforms, from analog to digital, from wires to wireless, from centralized systems to distributed, from old computer languages to new and from main frame computers to servers, workstations and micros.

- the carriers have pressure to improve productivity and find new revenue sources such as competing for the fast growing international traffic and the creation of teleports.

3. CARRIER OVERALL REQUIREMENTS

Figure 1 shows the typical public switched telephone network topography with the various classes of central offices. It also shows the demarcation between long distance or interexchange carriers (IXCs) and the local exchange carriers (LECs). This type of demarcation is new or does not exist in a number of countries. However, it is an indication of the new competitive environment which has existed for some time in the U.S. and is now being implemented in some form in many countries.

The enhanced operator and information services are normally added to the Class 4 Toll Tandem exchange of the LEC as indicated in Figure 1. The long distance

Public Switched Telephone Network

Analog and/or Digital

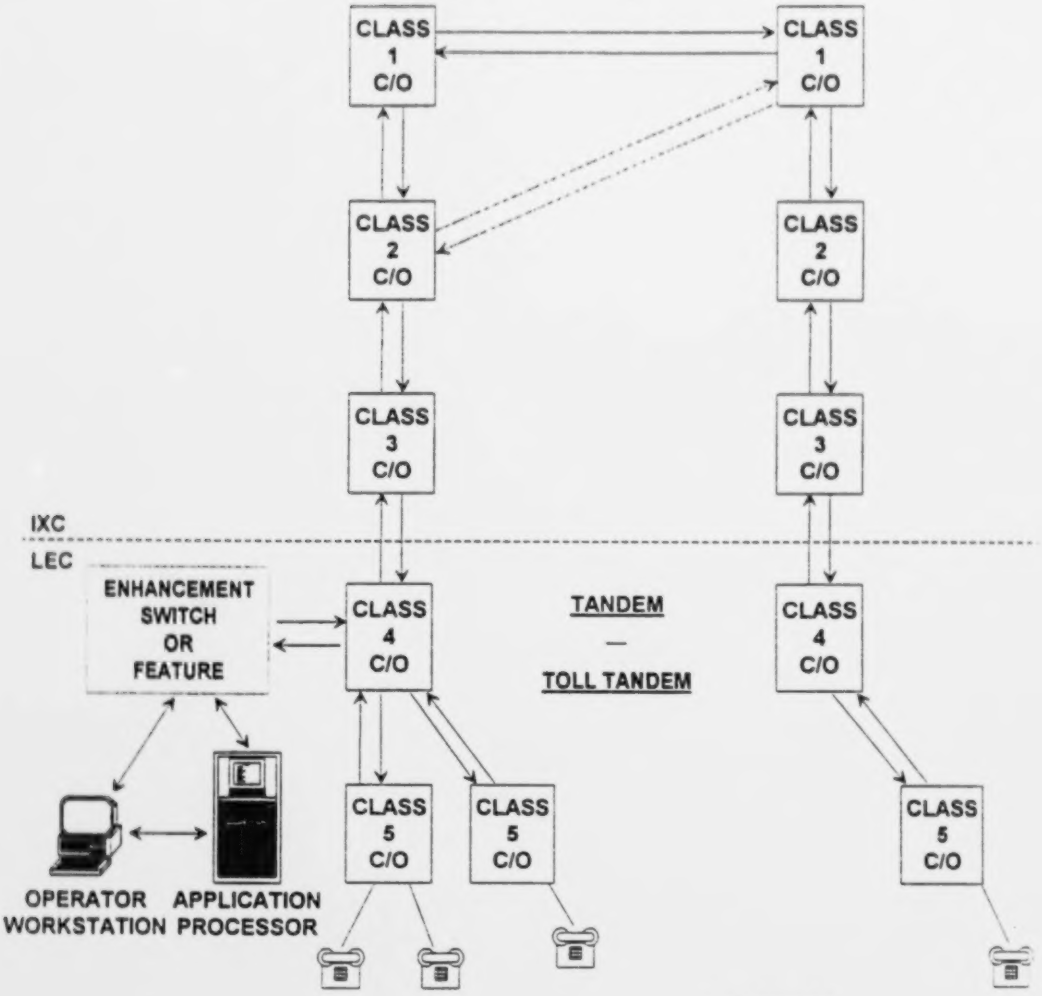
CLASS 1 C/O
CLASS 1 C/O
CLASS 2 C/O
CLASS 2 C/O
CLASS 3 C/O
CLASS 3 C/O
IXC
LEC
ENHANCEMENT SWITCH OR FEATURE
CLASS 4 C/O
TANDEM
—
TOLL TANDEM
CLASS 4 C/O
OPERATOR WORKSTATION
APPLICATION PROCESSOR
CLASS 5 C/O
CLASS 5 C/O
CLASS 5 C/O
END OFFICE
—
SUBSCRIBER OFFICE

FIGURE 1.

carriers and international carriers can add them to their gateways and to their central offices designated as operator service centers. Figure 1 shows the three major components that make up an operator services system which includes a separate enhanced operator services switch or the feature built into the Class 4, operator workstations and an operator and information services application processor. This section summarizes the telecommunications carrier's overall requirements for the three major components of the Enhanced Operator and Information Services Systems.

The general customer requirements, the customer being the telecommunications carrier and the supplier being the manufacturer of the enhanced operator and information services system, is shown in Figure 2. The system includes a transparent switch, operator positions and an applications processor which allows for the offering of data base and information services.

3.1 SWITCHING SYSTEMS REQUIREMENTS

The switch component of the system should be equal in availability to that of the standard digital public switched network toll exchange. It is required to be a fully redundant system for uninterrupted service. The switch is to be a fully digital tandem type of exchange with the ability to accommodate local exchange switching functions.

In order to insure uninterrupted service the switching system is to be self diagnosing for in-service problem definition and allow for in-service maintenance to minimize down time.

The ability to concurrently support multiple toll exchanges is a key requirement in particular for those carriers that may be offering services to other interexchange and local exchange carriers or are centralizing. The switch must be capable of interfacing all types of central offices and networks including analog, digital, wireless, satellite systems and international gateways.

The switch must be designed based upon a flexible architecture which would allow for growth and for the accommodation of new features and functions.

3.2 OPERATOR POSITION REQUIREMENTS

The operator position is key since it is the person machine/system interface and is the support unit for the operator interface to the carrier's customer. The requirement is for an integrated intelligent workstation for the operator which is based upon standard PC or workstation products and standard operating systems.

The position should be capable of integrating voice and data, have direct access to the switch and direct access to the application processors. This is to allow for quick responses to the carrier's customers and to optimize on the operators work time.

Ergonomic design of the keyboard and display is of prime importance and is to include function keys, color-coded function groups and keyboards designed for specific applications. Special operator support features are also required which include digital voice announcements, digital voice recording and the capability to have one position handle multiple types of operator and information services.

3.3 APPLICATION PROCESSOR REQUIREMENTS

The application processor is to be a high speed real-time computer. It is to be based upon a standard commonly available server machine using a standard operating system and data base management system. It should be capable of local data base support and have the ability to access remote data bases and computers. Its local and remote data base access system has to have the capability to support billing and accounting functions.

The ability to provide the operator access to multiple applications is mandatory. These applications include standard applications like directory assistance and toll assist and special information services such as well care, hotel billing and prison systems.

Reliability and redundancy is another requirement of the application processor. It should have the ability to operate in a hot stand-by mode in a duplexed configuration and should have the capability to have a duplicate and back-up database and file system.

4. DEVELOPING COUNTRIES REQUIREMENTS

The implementation of traditional public telecommunications technologies will not allow the developing countries to reach the required telephone, data terminal, fax and integrated terminal population per capita necessary for development.

New and innovative approaches are required including approaches to the regulatory and telecommunications industry infrastructure. In most cases, using the developed countries as a model is not appropriate for the development of telecommunications in the developing countries.

The most important issue for the telecommunications carriers of developing countries is to define the technologies it requires to provide the necessary and required services to the populace, businesses and institutions based on what is proven and available. In addition, the carriers must capitalize on existing installed equipment and optimize on the new.

4.1 BASIC NEEDS

The need is for a basic reliable universal service that provides a

General Customer Requirements

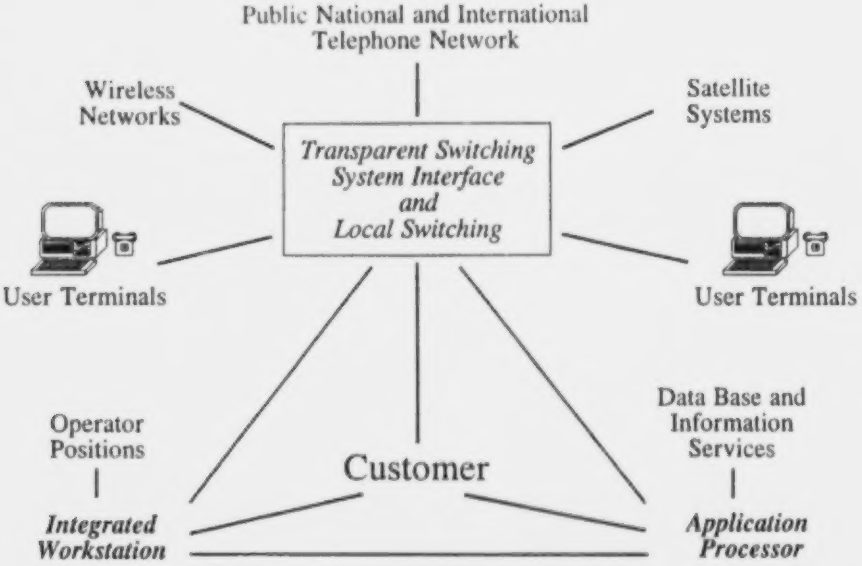
Public National and International Telephone Network
Wireless Networks
Satellite Systems
Transparent Switching System Interface and Local Switching
User Terminals
User Terminals
Operator Positions
Data Base and Information Services
Customer
Integrated Workstation
Application Processor

FIGURE 2.

Enhanced Applications/Services Platform Technology

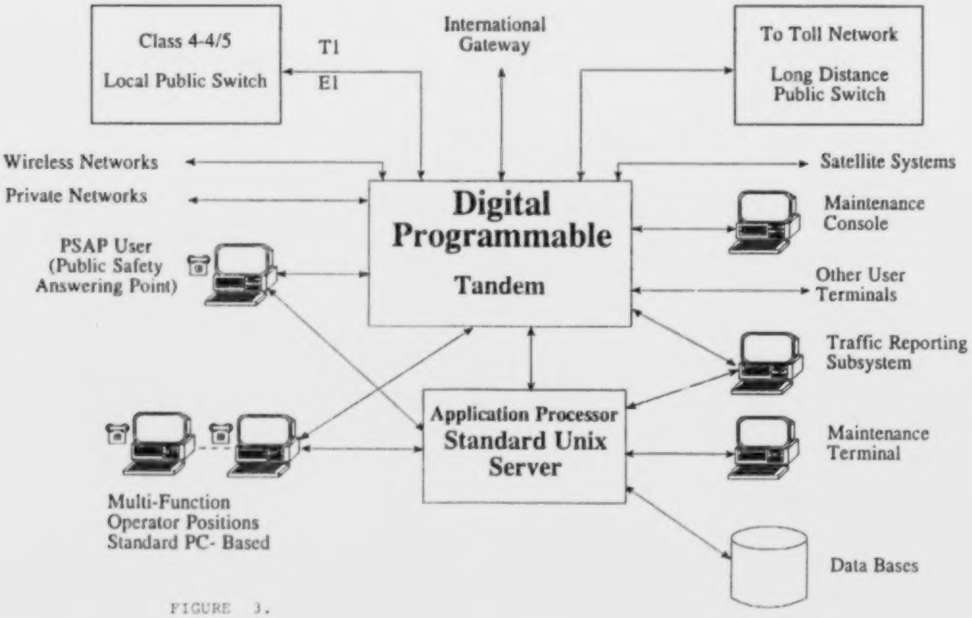
Class 4-4/5
Local Public Switch
T1
E1
International Gateway
To Toll Network
Long Distance Public Switch
Wireless Networks
Private Networks
Satellite Systems
Digital Programmable
Tandem
Maintenance Console
PSAP User (Public Safety Answering Point)
Other User Terminals
Traffic Reporting Subsystem
Application Processor
Standard Unix Server
Maintenance Terminal
Multi-Function Operator Positions Standard PC- Based
Data Bases

FIGURE 3.

foundation for future growth and new services. This service needs to be first available to at least public areas of every hamlet, town, village and city. Implementation is to be quick and easy.

Certain operator services, such as directory assistance and toll call assistance, are essential. In addition, there is a need for emergency and disaster control systems. These systems are required to optimize on the country's languages and dialects. Also needed is the development of a method of simplified billing

4.2 SPECIFIC REQUIREMENTS

The requirements for operator and information services of the developing countries carriers are driven by country specific requirements which include the following:

- the switching system needs to interface with old analog electromechanical exchanges and signaling systems in order to offer the operator services enhancements to such systems. The switch may require the capability to access a satellite earth station and to interface a radio based network.

- the operator positions must have a national language keyboard and function keys designed for country specific applications. The displays on the screen are to be in the national language.

- the application processor and data base machine need to have its data base in the national language and format. In particular the names in the directories. Applications unique to the country can be added by the carrier.

- the system should have local content. This could be in the form of technology transfer in regard to the building of the switch and the development of the software. It can also include locally manufactured and/or assembled PCs as operator positions and locally available UNIX file servers as application processors.

5. APPLICATIONS

The enhanced operator and information services applications include:

- Directory Assistance
- Automated Yellow pages
- Property Database
- Enhanced E911
- International Gateway
- Automatic Message Accounting
- Prison Call Management
- Mobile/Marine Radio
- Automatic Rating
- Credit Card Calls
- Local Debit Cards
- Billing
- Booked Calls
- Intercept
- Well Care
- Message Center
- Hotel Billing Information Center
- Telecommunication Relay Service

5.1 ENHANCED DIRECTORY ASSISTANCE

The Directory Assistance application provides a multiple search criteria to prompt the operator for the proper response to the inquiry. The search criteria is based upon name, address, city and other criteria. It also provides digital voice response. A new feature, call completion, allows for automatic dialing once the correct number is found.

Another type of directory assistance is the Automatic Yellow Pages which provides the carrier a database that can be accessed by product or service. As with directory assistance, the selected number can be automatically dialed forward.

5.2 PROPERTY DATA BASE

The Property Data Base application enables the carrier to enter and maintain certain information about a property associated with a specific telephone number. This information is displayed on the operator's screen when a call comes in. For example, the application can enable the operator to provide customized greetings and determine what services are available for a particular property.

In a similar fashion the Emergency Number Data Base application enables the carrier to enter and maintain the necessary emergency numbers associated with a particular property or phone.

5.3 CREDIT CARD VALIDATION

This application provides access to credit card data bases for card validation and authentication. It is capable of accessing most available external data bases via X.25 or other protocols as required. The Credit Card Validation application provides for optional automatic call completion without operator assistance on validated credit cards.

5.4 ENHANCED 911 SERVICE

This application allows for two types of calls; emergency calls dialed with 911 and emergency calls dialed with 0.

When a 911 call is received by the system it is directed to a dedicated terminal in the appropriate Public Safety Answering Point (PSAP), which is selected based on the ANI (Automatic Number Identification) of the calling party. A PSAP workstation has a unique display and the operator performs no other call handling functions except E911. All calls are recorded and archived.

5.5 OTHER APPLICATIONS

Each operator and information service application is a paper in itself and cannot be adequately described here. The purpose of this section is to make the reader aware of a myriad of such applications which are available and also, that there are systems in existence which enable the carriers to add their own unique applications.

The Telecommunications Relay Service application, for example, is for the visual or hearing impaired to communicate with others via an operator by using a keyboard device. The operator (Communication Assistant) provides the appropriate text and speech conversions.

6. TECHNOLOGY TO MEET REQUIREMENTS

Figure 3 shows an Enhanced Operator/Information Services Platform Technology which meets the requirements as stated in the previous sections.

The digital programmable tandem switch appears as a tandem to the network and allows for the addition of the new services to the existing network and switches. It has the capability to interface a local Class 4 or 4/5, an international gateway, a satellite system, wireless networks and private networks. It supports all carrier operator functions and can interface multiple switches simultaneously.

The switch is the first leg of a three legged architecture consisting of the switch, the operator positions and the application processor. All three legs are interconnected to allow for efficiency, reliability and speed.

The second leg is the operator position which is an integrated function workstation based upon a standard IBM compatible PC and MSDOS. It includes a specialized operator services keyboard and the ability to perform multiple functions from a single position including all applications described in this paper as well as multiple languages. The operator position communicates with the switch at 9600bps and with the applications processor over Ethernet at 56kbps.

The applications processor is the third leg and provides for all the data bases for all the applications both locally and remotely. It also interfaces a host computer for automatic billing and an Automatic Message accounting tape. It interfaces the switch at 9600bps and is the file server for the operator positions. The applications processor is a standard UNIX machine and is programmable by the carrier.

The systems architecture as shown in Figure 3 allows for the networking of such systems, adding remote concentrators and expanding the size of the system to handle large numbers of operator positions and additional trunks. The architecture also allows for the addition of new and enhanced applications. Most important, due to the transparency of the switch, it can enhance old and new networks and central offices.

7. CONCLUSIONS AND RECOMMENDATIONS

The developing countries should consider all available resources and routes at their disposal in order to implement a telecommunications system which can provide basic reliable services with a foundation for future services. Railroads and utilities can assist in providing complementary infrastructures to the existing telephone networks. The national and international satellite systems can be used to develop alternate and complementary approaches. Cellular and PCN technology can be used in lieu of stringing wire and burying copper. A new regulatory environment is required to allow for the optimization of resources.

The existing public national and international telecommunications networks can be enhanced with new information technology products. This will allow for new information and operator services as described in this paper including applications which are customer and country specific. Existing analog switches and new digital switches can be enhanced by attaching state of the art operator workstations based upon PCs, application processors based on UNIX LAN servers and small digital toll switches based on micro computers. These three components tied together into a systems architecture allow the carrier to provide a variety of new services without the need to replace existing switching systems. In addition, such architecture can enable the enhancement of local exchanges to provide custom calling features and usage sensitive pricing.

The carrier can then have the opportunity to provide the outsourcing of operator services to hotels, institutions and businesses through the implementation of enhanced information and operator systems. Such systems can apply to all types of services such as teleports, international gateways, wireless services and future multimedia services.

It is not necessary for developing countries to evolve in telecommunications in the same manner as the developed countries. In fact, such an evolution can be a retarding force on the development of a country. By taking new approaches and implementing state of the art information technologies (which include telecommunications and computers) a developing country can create its own indigenous telecommunications industry. This can occur by forming strategic alliances, joint ventures, and business relationships with entrepreneurial fast moving high technology companies of the developed countries. These companies are able and willing to provide technology transfer and knowhow. The traditional telecommunication companies are not geared in that direction. In addition, the new innovative international carriers are usually entreprenuerial and can readily form alliances to provide new and competitive services.

The developing countries will find that the high technology and new carriers of the U.S. are willing to consider the trade of technology and know how for investments and expanded markets. Such companies are researching, developing, manufacturing and/or offering digital switches, satellite communication systems, radio frequency components and operator/information services systems. A survey of such companies, a number of which are members of PTC, would be appropriate prior to a developing country committing to a traditional network implementation and business relationship.

This paper has only covered one area of the technologies available which assist in the implementation of new telecommunication services and enhancements of existing services and networks. It is hoped that it has given some input to those in decision making positions in the developing countries.

Expanding the Boundaries of the Internet Using a Low-cost Small-channel Satellite Network

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1 Abstract

In this paper, we propose an easy and cheap way of expanding Internet to the regions which are at a disadvantage in making use of the resource-rich Internet due to geographic or economic reasons. The proposal envisages a low-cost, low-bandwidth satellite-based computer network, for providing cheap and easy connectivity among people over a very wide area. The satellite network will be linked to the Internet at one or more points. In this paper, technical issues, experiments and future plans are discussed.

2 Introduction

The Internet has advanced and expanded at a very rapid pace. Millions of people in more than 50 countries benefit from the near-global span of this network. The Internet is presently not only a media for easy communication between people at far distances but is also a very rich source of information. Nevertheless, there are regions which due to geographic and/or economic reasons are at a disadvantage in making use of this rich resource. Particularly areas, which are sparsely populated and are not members of rich economies, are well beyond the reach of the Internet.

In this paper, we propose an easy and cheap way of expanding Internet to these areas. This plan is part of an ongoing collaborative effort the groundwork of which has been laid by the PEACESAT[1](Pan-Pacific Education and Communication by Satellite) Project. It used the ATS-1 to establish and support an active and non-profit network in the Pacific area for 18 years until the satellite ceased its operation in 1985. The results of the ATS-1 network activities lead to the unmistakable conclusion that such networks are very useful in regions (e.g. the Pacific region) where the normal modes of communication are somewhat difficult and complicated due to geographic or economic factors. While the search for an appropriate satellite is going on, experiments have been continuing on various aspects of the satellite based network. At present the U.S. meteorological satellite GOES-3 is being used to support the essential network infrastructure of the project. The PEACESAT Expansion Information Network[2, 3] aimed at experimenting on some of the engineering and technological aspects using the Japanese ETS-V satellite. Among the issues examined notable are- expanding the service coverage, providing an environment of mutual communication and information exchange in the fields of education, research and health in Pacific region etc.

Aiming for more ambitious goals the PARTNERS computer network project was promoted to examine the possibility of providing access to Internet resources using the Satellite-based computer network. This computer network will provide cheap and easy connectivity among people over a very wide area. The satellite network will be linked to the Internet at one or more points.

To keep resource requirements to a minimum, low-cost earth stations have been designed and developed using off-the-shelf components by a volunteer group, and small PC-based systems with UNIX and TCP/IP are used as the base platform[4]. This configuration opens up the vast resources of the UNIX-based PDS to the users.

The design envisages access to all the Internet services, such as *mail, Directory, Screen-talk, Gopher , Archie, Soft-Pages and Bulletin Board* etc..

As a pilot experiment, the use of the ETS-V satellite to construct this low-cost, low-bandwidth network, is targeted.

The planned satellite based network has it own characteristics. In contrast with the usual high bandwidth LANs and WANs which comprise the Internet the channel capacity will be low [9.6 kbps] and the communication will be of broadcast nature.

The related technical issues, experiments, problems and solutions are discussed in the paper.

3 ETS-V experimental satellite network

The ETS-V satellite was launched by NASDA(National Space Development Agency of Japan) in August, 1987. The location is 150 degree east and it carries a L-band transponder and a L-band antenna. The L-band antenna beam coverage is shown in Fig.1.

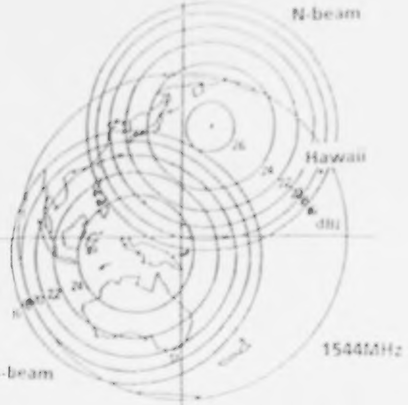

N-beam
Hawaii
26
24
dBi
22
24
1544MHz
S-beam

Figure 1: L-band beam coverage of ETS-V

The earth station has been designed by the researchers of Communication Research Laboratory, Ministry of Posts and Telecommunications. Major characteristics of the earth station are listed in Table 1. The main features of this earth station are its simplicity and low cost. The antenna, transmitter and receiver are configured by electronic components almost all of which are easily available in the market. The frequency converter is configured by converting amateur radio equipment.

Transmit Frequency	1644-1645.5MHz
Receive Frequency	1542-1543.5MHz
Antenna System	Transportable Parabolic 3 m diameter
Low Noise Amplifier	55K, GaAsFET
Modulation System	QPSK, 128kbps NBFM(order wire)
Error Correction	Convolutional Encoding (R = 1/2,k = 7) viterbi Decoding (soft Decision)
Data Rate	64kbps

Table 1: Characteristics of earth station

Fig.2 shows the communication interfaces of earth station. There are several different interfaces designed for the earth station. In this work, we use the RS232C interface, which has a speed of 9.6 kbps.

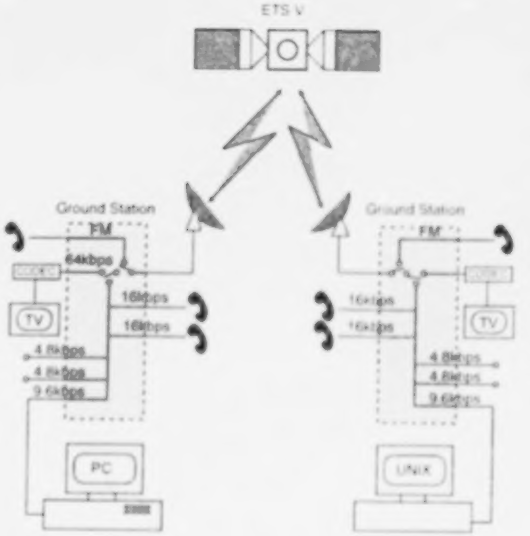

ETS-V
Ground Station
FM
64kbps
CODEC
TV
16kbps
16kbps
4.8kbps
4.8kbps
9.6kbps
PC
Ground Station
FM
CODEC
16kbps
16kbps
TV
4.8kbps
4.8kbps
9.6kbps
UNIX

Figure 2: Communication interfaces of Earth Station

4 Formation of PARTNERS computer network

Until now, many experiments such as trials on distance education and training, video conferencing have been conducted between Japan and other regions which participate in PARTNERS project[5]. In this paper, we mainly focus on PARTNERS computer network.

Fig.3 shows the configuration of the proposed PARTNERS computer network. Basically, this network consists of ETS-V satellite communication system, the personal computers and UNIX workstations. In order to access the Internet,

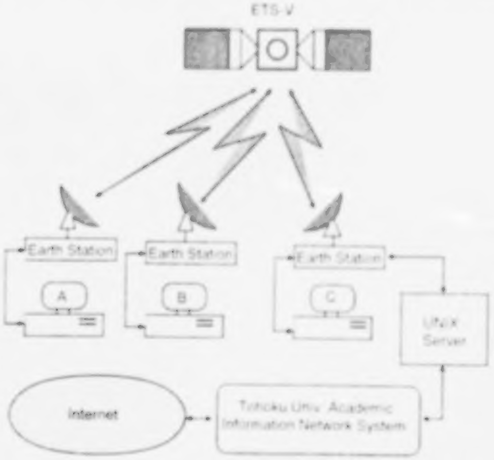

ETS-V
Earth Station
Earth Station
Earth Station
A
B
C
UNIX Server
Internet
Tohoku Univ. Academic Information Network System

Figure 3: PARTNERS computer network

a SUN workstation was introduced, also for getting the routing information around the world, the UNIX machine was set on Tohoku University Academic Information Network System(TAINS), which is a local area network. The personal computers are IBM compatible machine Compaq Prolinear 4/25 model. In PARTNERS computer network, client PCs use SLIP(Serial Line Internet Protocol) which supports point-to-point TCP/IP protocol to connect the server. The basic operation system used on Compaqs is 386BSD system. 386BSD system is a free software includes X11 window system. This system is now available from many *ftp* sites around the world. Generally, 386BSD requires 8Mbytes main memories and 80 Mbytes hard disk.

5 Experiments of PARTNERS computer network

First of all, we conducted the experiments inside Japan between Tohoku Univ. of Sendai and Communication Research Laboratory(CRL), Ministry of Posts and Telecommunications in TOKYO. In this section, we introduced some very useful computer applications which were developed or installed for PARTNERS computer network.

Fig.4 is the initial screen on a PC client. Following this initial screen, menu screen appears as shown in Fig.5. One can use the system as a general UNIX system, or select the prepared applications.

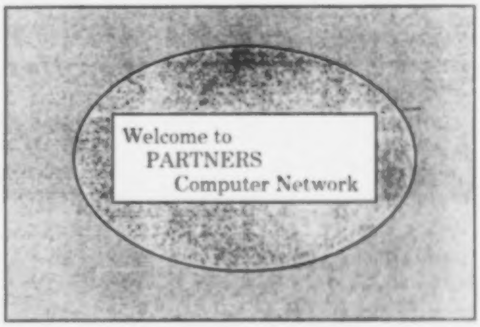


Figure 4: Initial screen of PC client

5.1 Directory service

The directory service is intended to support human user querying, allowing users to find, inter alia, telephone and address information of organizations and other users. The directory can be decomposed into objects as in Fig.6. A user accesses the directory by means of a Directory User Agent(DUA). The DUA communicates with the directory by using Directory Access Protocol(DAP). The directory is organized hierarchically in the form of a tree. The directory database is usually referred to as the Directory Information Tree(DIT). The first level of the directory is country, and organization, organization unit and person follow on. Fig.7 shows an example of the final stage of directory service. we can see the individual information is shown in this figure.

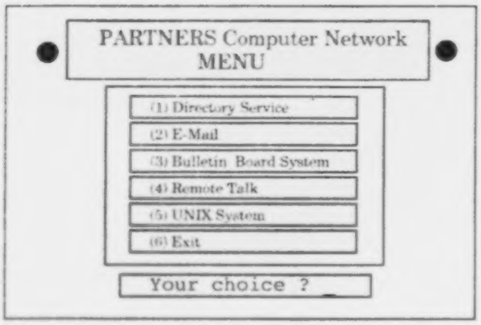


Figure 5: Menu screen for selecting main applications

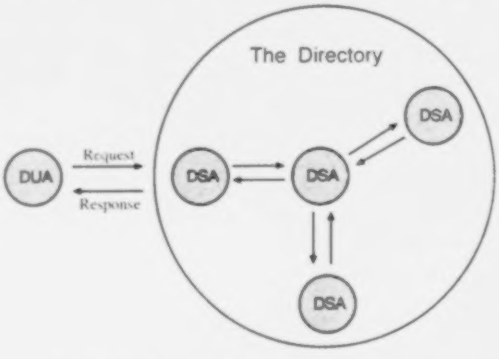


Figure 6: Schema of the directory system

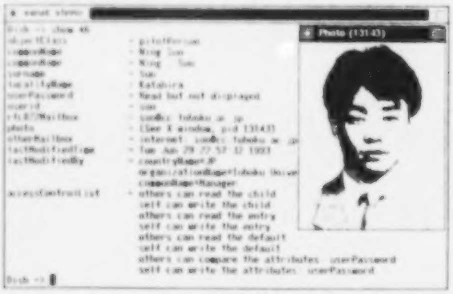
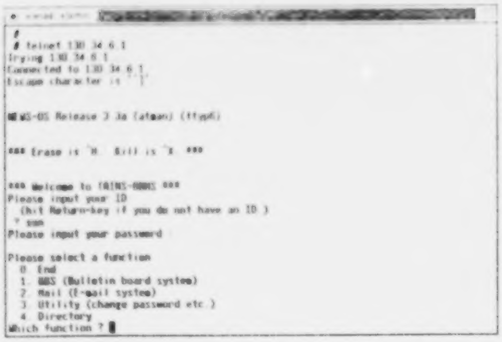


Figure 7: An example of Search result in the directory

5.2 Bulletin board system

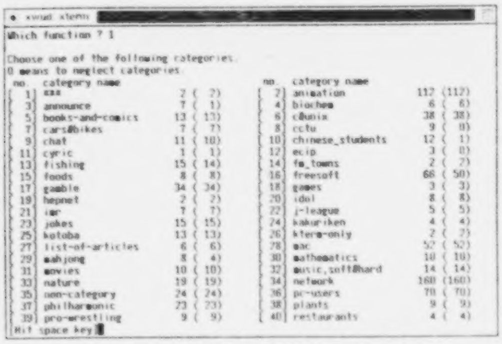
The bulletin board system is developed and installed on a UNIX machine located at Tohoku Univ.. When the BBS is selected, the PC will try to connect this BBS server

BEST COPY AVAILABLE



```
#
# telnet 130.34.6.1
Trying 130.34.6.1
Connected to 130.34.6.1.
Escape character is '^]'.


WS-OS Release 3.3a (atman) (ttyp4)


*** Erase is ^H. Kill is ^X. ***


*** Welcome to TAINS-NBBS ***
Please input your ID
  (hit Return-key if you do not have an ID )
 ? sun
Please input your password :

Please select a function
  0. End
  1. BBS (Bulletin board system)
  2. Mail (E-mail system)
  3. Utility (change password etc.)
  4. Directory
Which function ? 
```

Figure 8: Initial screen of bulletin board system



```
Which function ? 1

Choose one of the following categories.
0 means to neglect categories.
 no.  category name                         no.  category name
[  1] aaa                 2 (  2)          [  2] animation          112 (112)
[  3] announce            7 (  1)          [  4] biochem              6 (  6)
[  5] books-and-comics   13 ( 13)          [  6] c&unix              38 ( 38)
[  7] cars&bikes          7 (  7)          [  8] cctu                 9 (  0)
[  9] chat               11 ( 10)          [ 10] chinese_students    12 (  1)
[ 11] cyric               1 (  1)          [ 12] ecip                 3 (  0)
[ 13] fishing            15 ( 14)          [ 14] fm_towns             2 (  2)
[ 15] foods               8 (  8)          [ 16] freesoft            66 ( 50)
[ 17] gamble             34 ( 34)          [ 18] games                3 (  3)
[ 19] hepnet              2 (  2)          [ 20] idol                 8 (  8)
[ 21] iar                 7 (  7)          [ 22] j-league             5 (  5)
[ 23] jokes              15 ( 15)          [ 24] kakuriken            4 (  4)
[ 25] kotoba             13 ( 13)          [ 26] kterm-only           2 (  2)
[ 27] list-of-articles    6 (  6)          [ 28] mac                 52 ( 52)
[ 29] mahjong             8 (  4)          [ 30] mathematics         10 ( 10)
[ 31] movies             10 ( 10)          [ 32] music,soft&hard     14 ( 14)
[ 33] nature             19 ( 19)          [ 34] network            160 (160)
[ 35] non-category       24 ( 24)          [ 36] pc-users            70 ( 70)
[ 37] philharmonic       23 ( 23)          [ 38] plants               9 (  9)
[ 39] pro-wrestling       9 (  9)          [ 40] restaurants          4 (  4)
Hit space key
```

Figure 9: Categories of BBS

automatically, once the connection is completed as shown in Fig.8, the BBS asks users to input their ID.

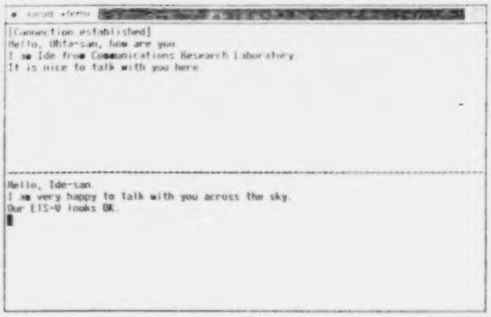
After the ID is input, the menu shown in Fig.9 appears, currently, the BBS includes about 50 categories and one can create categories by themselves at anytime, but if a category is not used more than two weeks, this category is designed to be deleted automatically.

5.3 Screen talk

Screen talk is a tool for communication between people at far distances by typing the characters on computer screen. Fig.10 shows the actual talk screen during a talk session, the upper half conatins messages from Tokyo while the lower half contains messages from Sendai.

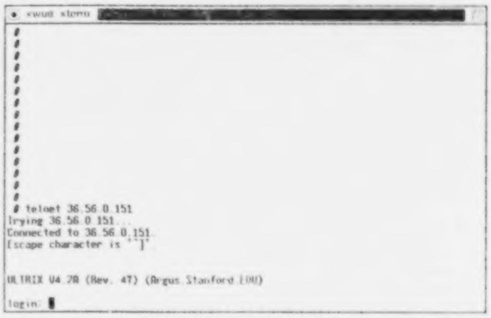
5.4 Remote login

Fig.11 shows how we use the PC to connect to a remote host computer. In this way , we can access all the computers that are connected on the Internet, and use all the services that are available in the Internet.



```
[Connection established]
Hello, Ohta-san, how are you
I am Ide from Communications Research Laboratory
It is nice to talk with you here
-------------------------------------------------------------
Hello, Ide-san.
I am very happy to talk with you arross the sky.
Our ETS-V looks OK.
```

Figure 10: Screen talk



```
#
#
#
#
#
#
#
#
#
#
#
#
#
#
#
# telnet 36.56.0.151
Trying 36.56.0.151...
Connected to 36.56.0.151.
Escape character is '^]'.


ULTRIX V4.2A (Rev. 47) (Argus.Stanford.EDU)

login: 
```

Figure 11: Remote login from clinet PC

5.5 Electronic mail

Electronic mail is a very useful communication method without the limitation of time, this is especially important for people at far distances. Electronic mail function is now available at UNIX server, and we prepared a registration program to register the users applying ID from client PCs automatically.

5.6 File transfer

Ftp is a tool for transferring files between computers. In the PARTNERS computer network, this is realized by SLIP which supports TCP/IP protocol. Table 2 shows the file transfer time by *ftp* on RS232C. At present time, 9.6 kbps is the maximum speed for PARTNERS computer network.

Size	Seconds
1 Kbytes	1.5
10 Kbytes	14
100 Kbytes	126

Table 2: File transfer time of **ftp**

Besides the usage we explained above, many public domain software such as *Gopher*, *Archie* and *SoftPages* also can be used from the client PC. This way, even people at a far distance can easily utilize the rich resource of the Internet through PARTNERS computer network as well as people in a good computer environment.

6 Engineering Issues

The planned satellite based network has it own characteristics. In contrast with the usual high bandwidth LANs and WANs which comprise the Internet the channel capacity will be low [9.6 kbps] and the communication will be of broadcast nature.

Among some of the engineering problems that have arisen in the proposed network the majority are of management in nature. For example:

- Management of fairness of bandwidth usage.
  The limitation of channel capacity demands the installation of some protocol to grant and ensure limited usage rights.
- Management of security.
  The braodcast nature of the communication over a wide-area network leads to grave security threats. Any one can eaves drop on the conversation by sniffing the waves. This area has been widely discussed in common networking - there are proposed techniques which use encryption. However for the distribution of keys and for authentication the services of a Directory needs to be explored.
- Management of management traffic.
  Present Internet management framework where manager polls agents to obtain information will not work due to the channel width limitations. Management will need to be distributed so that the impact on the satellite channel is minimal.
- Applications which make use of the special nature of the satellite network.

7 Concluding remarks

There are regions which due to geographic and/or economic reasons are at a disadvantage in making use of the rich resources that exist in communication networks. Particularly areas, which are very sparsely populated and are not members of rich economies, are well beyond the reach of the networks. In this paper, we have proposed a satellite based framework for expanding the span of the Internet, cheaply and easily, to such regions. We have conducted some basic experiments. The necessary software has been prepared - most of it has been extracted from existing PDS and part of it has been indigenously developed. All the necessary software will be made freely available to the participants of the Project.

Research and development is continuing to improve on the performance achieved during the experiment. A major thrust is given to speed up the interface of the earth station for realizing multimedia environment in the future, and to find a way to support broadcast communication. The Management issues that arise in this new kind of environment are presently under study. As a pilot experiment, we hope that the proposed concept will be an important step in revamping the condition of communication in the regions beyond present day networking, and propel the utilization of satellite technology to benefit more people in the world.

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AUTOMATED INTERNATIONAL TELECOMMUNICATION CHARGE CARD SERVICE - ("89" Service)

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MCI INTERNATIONAL
RYE BROOK, NEW YORK USA

1. ABSTRACT

International travelers need to call from anywhere to anywhere in a fast, easy, reliable and cost effective manner using calling cards is continuing to grow. For years, international business travelers, in particular, have been seeking alternative billing methods for the following call types:

- calls back to home country
- calls within a country
- calls to a third country

One answer to meet customers' needs is the establishment of bilateral automated telecommunication charge card service, otherwise known as "89" service. The following paper provides a historical perspective of "89" service and some basic marketing, commercial, technical guidelines and issues that MCI faced when assessing, negotiating, developing and/or establishing bilateral "89" service with a number of telecom operators.

Telecom operators have gathered under the guidance of ITU-Telecommunications formerly CCITT to meet the customers' growing calling card needs by updating the previous telecommunications charge card standards and upgrading and enhancing the associated technology.

Efforts have been focussed on the transition from the former international telecommunications service using the "M" number to the new "89" numbering standard (CCITT Rec. E.118). Over the last few years, the work also addressed the need to standardize a secure method of supporting the competitive needs of multiple telecommunications providers and card issuers within a single country and across national borders.

New standards have been adopted for the Automated International Telecommunications Charge Card Service with full positive validation. Guidelines have been set in ITU-T to help telecom operators utilize the "89" numbering system, provide the basis for how the service should operate on an automated or non-automated basis (CCITT REC.E.116) and describe validations procedures that should be used (CCITT Rec. E.113).
Telecom operators are still working hard in many areas to meet the customers' expectations and increase the acceptance of automated "89" service around the world. The following provides some suggested guidelines for key areas of focus for telecom operators who may be assessing or developing bilateral automated "89" service:

1) MARKETING
2) COMMERCIAL
3) TECHNICAL

1) MARKETING

-Strategic Objectives

- offering customers expanded calling capabilities
- achieving and or maintain parity with competitors in own multicarrier environment
- strengthening image as a full service provider in international calling card
- providing low cost home, intra and third country calling for frequent business traveler
- stimulating calling on own network

- "89" numbering (replaced the CCITT "M" Number Standard which was due to expire at the end of '93)

(KEY CCITT RECOMMENDATIONS to FOLLOW:

- CCITT Rec.E.118 - Number Format
- CCITT Rec. E.116 - Service Definition
- CCITT Rec. E.113 - Validation Message Components
- CCITT Rec. D.120 - Settlement/Collection Principles
- CCITT Rec. D.176 - Billing Record Exchange
- Standards actitivies are continuing in ITU-T and ISO

SAMPLE - MCI 89 Numbering
Primary Account Number (PAN) - maximum 19 digits

```
/-------------------\
89 1  222 XXXXXXXXXXL   PPPP
```

1. 89 = Telecommunications Industry Identifier
2. 1 = Country Code for North America
3. 222 = Issuer Identifier
4. X = Subscriber number
5. L = Luhn Modulus 10 Check Digit
6. P = Personal identification number (PIN)

- Card Fulfillment/Order Entry
  Normally, each carrier has been responsible for their own issuance of cards and order process and order control.

- Customer Access Procedures

  Customer access procedures vary significantly today. Uniform customer Access procedures are now addressed in ITU-T Study Group 1 Questions 6. Currently, access may vary for card readers, automated access and operator access. Some automated systems have voice prompting, operator fallback, the ability to prompt for an operator, and follow on call capability.

- Customer Service
  Customer service procedures for "89" service was also addressed by MCI such as:

  - Lost or stolen card
  - Invalid Card Number (PAN)
  - Invalid PIN
  - Dialing assistance
  - Directory Assistance
  - Language Assistance
  - Rate Quotes

2) COMMERCIAL

- Key Issues/Concerns

Currently, one of the primary commercial concerns in bilateral "89" negotiations has been the concern over the rating home country calls. A number carriers have requested that home country calls be handled on a settled basis whereby the card issuing carrier reimburses the card handling carrier an IDD settlement for use of their respective networks. This was traditionally how the "M" number and country direct services have been handled.

Another group of carriers have requested that home country calls be handled on a origin of rating basis whereby the call handling carrier would receive the the full collection rate for home country calls from the card issuing carrier.

MCI has supported the settlement method for home country calls for a number of reasons such as customer perception, product positioning, product pricing and product profitability.

Other key areas that needed to be addressed when negotiating bilateral were as follows:

- reimbursement for intracountry and third country calls
- legal and regulatory issues (i.e. contract, taxes)
- responsibilities for fraud and bad debt
- administrative and billing charges
- timing for exchange of currency conversions and billing records

3) TECHNICAL

- Key concerns/issues

Choice of validation protocols including the message sets has been of key concern over the last few years. Should the protocol be SS7 TCAP, Global Calling X.25 , BT-MCI X.25 or another? MCI solution to the protocol issue was to build a flexible validation platform that could talk in multiple protocols and be easily adapted for new protocols.

Other technical areas that needed to be considered in bilateral technical discussions were:

- specific number formats
- access codes,
- dialing sequences
- transport of the call
- billing formats
- fraud controls.

FUTURE DIRECTION OF "89" SERVICE FROM A MARKETING PERSPECTIVE:

- common universal access number
- operator timeout/operator prompt option
- consistency in dialing plans
- uniformity in voice prompts/ multilingual voice prompts

- ability to route to multilingual operator and customer service representatives
- ability to automatically connect cardholder to the card issuer customer service center ability to support other calling features

FUTURE DIRECTION OF "89" SERVICE FROM A TECHNICAL PERSPECTIVE:

- flexible multiple protocol platforms for validation-existing X.25 and SS7 to allow for developing countries to enter the calling card market
- routing of the card call to the card issuers network for calls back to the home country
- capability of providing originating line number and terminating line number for enhanced fraud protection such as range restrictions
- supporting call disposition message for additional fraud and billing reporting, real time rating, real time, credit limits
- supporting customer selectable PINS and voice recognition
- ability to bill other services such as conference calling, voice messaging, information services, X.400 calls etc
- expansion of CCITT Rec.D.176 record to support exchange of information for other services ie voice messaging, conference calling and information services
- consistency in the magnetic stripe for swipe phone

INTEGRATED VOICE INFORMATION SERVICES AND THEIR APPLICATION IN ASIA-PACIFIC

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ABSTRACT

The telephone companies of North America are rapidly expanding a number of voice messaging/information services to their subscriber base. The architectural and infrastructure differences between North American and Pacific Rim networks are barriers to direct implementation of many of these services. On the other hand, there are needs for voice and facsimile information services in the Pacific Rim countries that require call handling capabilities often not provided in the North American systems. This paper discusses services that are being deployed on an Integrated Voice/Fax Information Services Platform to simultaneously satisfy many needs. These include virtual telephone service, call answer, voice mail, message delivery service, calling card service, automatic and operator-assisted audiotex, changed number notification and automated account collection improvement service.

ENHANCED NETWORK SERVICES AND SWITCHING SYSTEM CAPABILITIES IN THE NORTH AMERICAN MARKET

Over the last several years, the North American telephone companies have been implementing a number of enhanced network services, providing far more features than those included in basic telephone service. Some of these services take advantage of the wide spread deployment of Signaling System 7 (SS7) and the Custom Local Area Switching Services (CLASS) features that are now included in the generic programs of the electronic switching systems. SS7 and CLASS are used to provide services such as:

Return Call
Calling Line Identification
Selective Call Blocking
Selective Call Reception
Call Trace

SS7 and the Advanced Intelligent Network (AIN) architecture defined and supported by Bell Communications Research is in the early stages of implementation, but is providing "Call Control" services such as Free Line Calling (800 Service), Custom 800 Service Call Routing, Calling Card Validation and other Line Identification Data Base (LIDB)-related services. These services rely on the availability of AIN trigger points in the call processing models of the switching system generic programs and the ability of the switching systems to communicate with Service Logic Programs in external Service Control Point computer systems over the SS7 network.

The North American telephone companies are now also providing a growing number of "Caller Interaction" services, using the digital voice storage and retrieval capabilities that have been implemented in computer systems over the last decade. These include such services as:

Call Answer, which replaces the need for customer telephone answering machines.

Voice Mail, which allows subscribers to communicate in non-real time.

Message Delivery, which allows subscribers to record messages that are automatically delivered by the system at a later time.

Audiotex, which makes various types of information available to callers.

Interactive Voice Response, which is used for applications such as Bank By Phone, Account Inquiry and Product Ordering.

The Caller Interaction services such as Voice Mail, Message Delivery, Audiotex and Interactive Voice Response demand little from the network switching systems other than the connection of the call to the service platform. In some cases, for billing or validation purposes, the switching system may also provide calling line identification as part of the call set-up procedure.

Call Answer service requires the ability of the switching systems to recognize calls destined for lines that are "busy" or "do not answer" and divert those calls to the service platform, automatically identifying the called telephone number.

The switching systems also have the ability to receive messages from the service platform to activate Message Waiting Indication (MWI) on the subscriber line when new messages are received. MWI may take the form of a unique dial tone (stutter dial tone) when the subscriber next goes "off hook" or may be implemented by control of a lamp on the subscriber's telephone.

In North America, the switching system capabilities to provide CLASS services, basic AIN services and Caller Interaction services are generally available. In most cases, even the earlier analogue electronic switching systems have the same basic capabilities as the newer digital switching systems.

THE NETWORK ENVIRONMENT AND CAPABILITIES IN PACIFIC RIM, ASIAN AND INDO-CHINESE COUNTRIES

With some notable exceptions, the switching system capabilities to provide enhanced network services are not ubiquitously available in the Pacific Rim and neighboring countries. Indeed, many telecoms are struggling to provide basic telephone service to all the people who want it. Privatization of telecoms and other strategies are being used to increase the amount of capital available to expand the network infrastructure. While switching system modernization is well underway in many countries, it will take many years to provide adequate distribution plant facilities so all who want telephone service can quickly be served.

On the other hand there are a number of Caller Interaction and adjunct services that can be provided with only basic switching system capabilities, even in an electromechanical switching environment. In some cases, these services can temporarily substitute for the lack of network infrastructure and switching system capabilities. Services can be provided to improve access to communications and information for all people, even those without basic telephone service. In the following sections, we discuss some of those services that are now being implemented around the world on the Unisys Network Applications Platform (NAP).

In a manner of speaking, the implementation of these new, integrated services will contribute to closing the "Missing Link."

VIRTUAL TELEPHONE SERVICE

The telecom assigns a group of telephone numbers to the service platform as if it were a local switching office. Subscribers to the Virtual Telephone Service are assigned one of the telephone numbers in that group. When that telephone number is dialed from anywhere in the world, the call is routed to the service platform. The called telephone number is passed to the platform as part of the call set-up process.

The service platform recognizes that the call is for a virtual telephone subscriber, therefore it retrieves and plays the greeting message that has been recorded by the subscriber, such as:

"Hello, this is John Wong. Please leave a message for me when you hear the tone and I'll call you back as soon as I can."

Subscribers call periodically, from any telephone to check for their messages. Upon successful entry of their virtual telephone number and passcode by DTMF tone dialing, they may listen to their messages, which may then be saved or deleted.

As an option, the service platform can notify the subscriber that there are messages waiting via a radio paging system.

Another option, soon to be available, allows the virtual telephone service subscriber to designate a telephone number to which incoming calls are to be switched (instead of being answered by the voice messaging system). The call is only answered by the voice messaging system if the called number does not answer within some number of ringing cycles.

CALL ANSWER SERVICE

For subscribers in areas served by modern switching systems with remote call transfer capability, the Telecom may offer Call Answer service. When the called subscriber's line is busy or does not answer after some predetermined number of rings, the call is transferred to the service platform. The switching system sends the called subscriber's telephone number to the service platform during the call set-up process.

The service platform fetches and plays the subscriber's greeting message, inviting the caller to leave a message. Upon receipt of the message the service platform communicates with the switching system to activate a call-waiting indication on the subscribers line.

The subscriber calls in to the system to retrieve the messages in the same manner as the virtual telephone service subscriber, above.

VOICE MAIL SERVICE

Voice mail service may be offered to telephone subscribers with actual or virtual telephone service. They may dial into the service platform from any telephone and, after successfully entering their telephone number and passcode by DTMF tone dialing, may record and address a message to any other subscriber who has voice mail service. By using the "Group Broadcast" feature of the voice mail service, they may send the same copy of the recorded message to a group of voice mail subscribers.

After listening to received messages, the subscriber has the capability to save the message, reply to the message (without entering the reply address) or forward the message to another voice mail subscriber(s), with a forwarding message.

MESSAGE DELIVERY SERVICE

Generally offered as a feature of voice mail service, Message Delivery service allows subscribers to record a voice message and address it to be delivered to a telephone line, rather than a voice mail box. The subscriber may specify the date and time that the message is to be delivered. At the specified time, the service platform makes a call to the addressee's telephone line and, upon receiving indication of answer, plays the message.

By the very nature of the service, to deliver the message at any date and time, it may also be used as a "Wake Up" or "Reminder" service. In this case, the subscriber will address the message to his/her own actual telephone line.

CALLING CARD SERVICE

Calling Card service allows people without telephone service or people who are away from their telephone to make inter-city or international calls from any telephone. Subscribers to this service will either establish a "debit account" with the telecom or purchase a "value card" issued by the telecom. In either case, the subscriber has an account number and Personal Identification Number (PIN) that is used when accessing the Calling Card service on the service platform. The subscriber's cash balance, either in the debit account or as indicated on the value card, is maintained in the files of the service platform.

After entry of the account number and PIN, the subscriber dials the telephone number that they wish to call. The service platform makes the call, then times and rates it, reducing the subscriber's balance in real time. Notification is made by the service platform when the cash balance permits only 15 seconds more time on the call.

Upon expiration of the cash balance in the account or as provided by the value card, the call is terminated by the service platform.

AUDIOTEX INFORMATION SERVICES

Audiotex services are provided to satisfy the people's need for information. There are two types of Audiotex services that are provided on Unisys NAP, i.e., Automatic and Manually provided information, each with options.

Automatic Audiotex services are accessed by dialing a telephone number that routes the call to the service platform. For directly-provided information, the called telephone number identifies the message to be played. For menu- selected information, the caller is greeted by a voice menu that defines the type of information that the caller may access and, upon selection, the proper message is played.

For manually-provided information, the caller is connected to an attendant who determines the type of information the caller wishes. The attendant may then connect the caller to one of the recorded messages, or retrieve the information from a data base in text form and speak it to the caller. The attendant may also connect the caller to a specialized information provider, such as a paralegal or a marriage counselor.

Billing for the various services depends upon the type of information provided and the connect time. The service platform creates the billing records and communicates them to the telecom billing system to be applied to the subscriber's bill.

CHANGED NUMBER NOTIFICATION

This service allows callers to hear the new telephone number when calling a subscriber whose telephone number has been changed. Calls to the old number are diverted by the switching system to a group of "intercept" trunks, connected to the service platform. Most modern switching systems also have the ability to transmit the old telephone number to the service platform.

The service platform finds the new telephone number related to the old telephone number, then speaks the new number to the caller using digitized voice. In custom installations, the message may even be in the subscriber's own voice.

AUTOMATED ACCOUNT COLLECTION IMPROVEMENT

Collection of accounts within the desired payment interval is a problem for many companies. The quality of payments is generally measured by the percentage of subscribers who pay their bill within 30 days of the billing date. As this percentage falls, telecoms may face cash flow problems.

Some telecoms have implemented applications to inform customers that payments on their account are overdue. In this case, the service platform is notified by the billing system that an account is in arrears. The service platform calls the customer at a time when the call is likely to be answered and plays a reminder or "courtesy" message.

If, after the passage of some days, the account is still not paid, the billing system notifies the service platform to call the subscriber to notify them that their service is being suspended for non-payment. After making the call the service platform communicates with stored program switching system to automatically suspend the service.

Where this application has been deployed, the percentage of subscribers paying their accounts within 30 days has risen significantly.

THE SERVICE PLATFORM

All the services described above, and more are implemented on the Unisys Network Applications Platform. NAP is a large scale, multiple services platform, designed to provide network- based services for the telephone companies of the world.

NAP currently provides the world's four largest voice messaging systems, serving the San Francisco Bay area, Greater Los Angeles, Eastern Massachusetts and the entire country of New Zealand. Installations in the People's Republic of China will implement not only voice messaging, but also many of the other services described in this paper.

NAP provides every type of network interface that is required to connect its enhanced services to the telephone network, incorporating a front end switching system, where required, under control of the service application. The largest installations can store thousands of hours of voice messages and hundreds of thousands of fax messages. A flexible service creation environment facilitates rapid customization and delivery of services to our customers.

OTHER SERVICES

Some other services which may be implemented in the Asia-Pacific telecoms include:

- Facsimile Messaging, including "never-busy fax," fax broadcast and fax mailbox service
- Telebanking
- Stock Market Information and Service
- Mass Calling

MORE INFORMATION

Unisys' world-wide headquarters is located in Blue Bell, Pennsylvania, USA. The headquarters for the Asia/Pacific Group countries is located in Hong Kong. The Latin American Country Group headquarters is located in Boca Raton, Florida, USA. There are many Unisys subsidiaries located in Pacific Rim countries to directly service our customers. Questions about NAP or the services provided by Unisys may be directed to any of our locations or may be directed to the author at his office in Blue Bell.

A SOUTHERN HEMISPHERE FIRST THE RED COSTERA SYSTEM

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1. ABSTRACT

The Venezuelan Festoon Cable System will span the Caribbean coast of Venezuela and provide a flexible communications superhighway. The festoon topology will link the heavily populated coastal communities which provide multi-point integration with the existing telecommunications network. This system shows what repeaterless fiber optic technology can provide today, and points to a multitude of continuing installations to serve the people of the world tomorrow.

2. Introduction

During 1993, I was privileged to work with Margus Telecom and members of the Venezuelan long distance telephone company (CANTV) in a close-knit team. The goals of our team were to plan, specify, survey, choose a supplier, and realize a festoon submarine cable system. The system will use the most advanced fiber optic technology, and will span the Venezuelan coast in the East-West direction. The system is known as RED Costera.

The services which RED Costera will provide for the Venezuelans and their world neighbors are summarized in Table 1.

3. RED Costera Routes.

Figure 1 shows the 10 repeaterless links which form RED Costera. Starting from Camuri, which is the landing point which serves the capital city of Caracas, five spans reach toward the East and five toward the West. The overall system spans from Maracaibo in the West to Carupano in the East. The Pointe Fijo to Coro span is terrestrial; the rest are undersea spans. Venezuela's geography and population distribution make it an ideal candidate for a coastal festoon system. Each of the eleven stations provides a drop-and-add point to knit this new communications superhighway into the existing network.

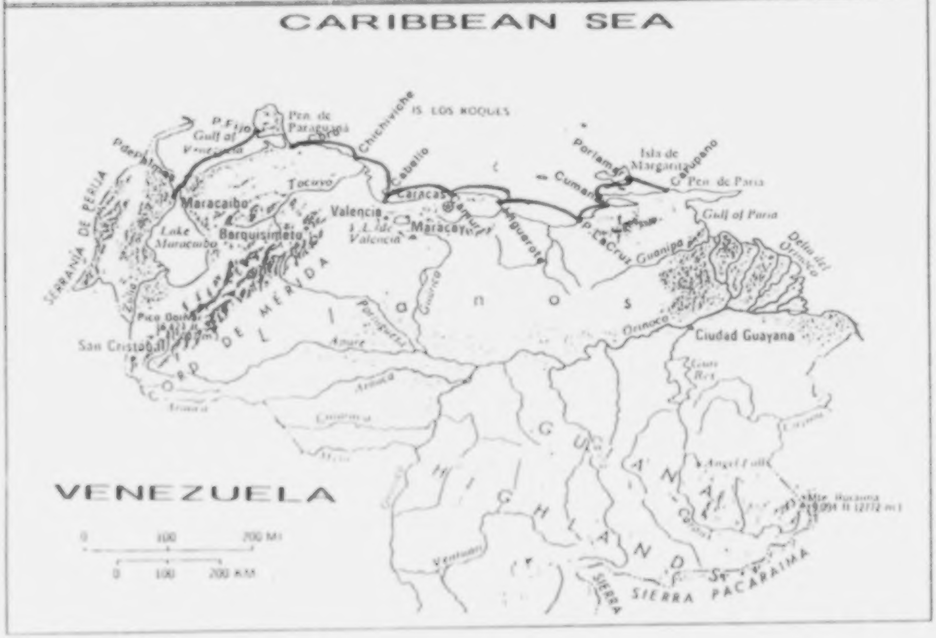
TABLE 1

Functions of RED Costera
· Major Backbone for Venezuelan Internal Communications
· Feeder to Connect Venezuela with International Network
· Transport Phone, Data, FAX, Video in a Flexible Stream

Although RED Costera is some 1450 km long overall, the longest span is 225 km, a span which can be handled without undersea amplifiers or repeaters. The long East-West coast of Venezuela and the large number of people living in coastal belt cities make the coastal festoon arrangement ideal to serve as a new backbone link for the national Network.

FIGURE 1

RED COSTERA.SYSTEM


CARIBBEAN SEA
P. Fijo
Pen de Paraguaná
Gulf of Venezuela
Chichiviche
IS. LOS ROQUES
Pdepalmas
Coro
Cabello
Porlamar
Isla de Margarita
Carupano
Pen de Paria
Cumaná
SERRANÍA DE PERIJÁ
Maracaibo
Tocuyo
Caracas
Valencia
Lake Maracaibo
Barquisimeto
L. de Valencia
Maracay
Higuerote
P. La Cruz
Gulf of Paria
Guanipa
Delta del Orinoco
Zulia
Pico Bolívar
San Cristobal
CORD DE MÉRIDA
Llanos
Portuguesa
Guárico
Apure
Orinoco
Ciudad Guayana
Arauca
Capanaparo
Meta
Caroni
GUIANA HIGHLANDS
Angel Falls
Mte. Roraima
Cuyuni
VENEZUELA
0 100 200 MI
0 100 200 KM
Ventuari
SIERRA
SIERRA PACARAIMA

4. Route Survey and Burial

Landing points and cable routes must be chosen with care to assure easy installation and to avoid existing natural or man-made hazards. Existing terminal buildings must be examined for space and load capacity, and adequacy of environmental controls. Span lengths are determined and plans made for types of armor and sections to be buried.

Ideally, we protect the cable from damage by anchors or fishing activities as shown in Table 2. The 2 meter depth protects against all hazards, including ship's anchors. Plowing to 1 meter depth protects against all fishing, clamming and scalloping hazards. A properly installed and buried cable simply does not become damaged from external aggression.

TABLE 2

Sea Depth	Burial Depth	Means
0 to 100m	2	Trencher m
100 to 500m	1	Sea Plow m

5. System Characteristics

General system characteristics of RED Costera are shown on Table 3. Placing the repeaters on land produces a major simplification from every point of view, including laying and burying the undersea plant. The cable contains dispersion shifted fibers, with the dispersion zero crossing near 1550 nm. This minimizes the dispersion penalty and opens two possible paths to upgrading the line rate to 5 or 10 Gb/s: either by using additional 2.5 Gb/s optical channels on each fiber or by increasing the rate on a single channel to 5 or 10 Gb/s. More about this later.

For the overall system of 1450 km, the bit error ratio will be better than 10^{-9}, while the longest span will deliver a BER of 10^{-10} or better.

RED Costera can suffer faults without dropping calls or creating service interruptions thanks to its capability of functioning in a ring configuration. In the face of a fault, signals are routed the opposite way around the ring.

6. Keys to Cost Effectiveness

Some keys to cost effectiveness are shown in Table 4. The cable carries its 24 fibers in 3 ribbons located in the heart of the cable, 8 fibers to a ribbon. This arrangement simplifies color coding, and opens up the possibility of gang splicing 8 fibers at a time.

TABLE 3

RED COSTERA - SYSTEM CHARACTERISTICS
· Fiber Pairs - 12 DSF
· Equipped Pairs - 2 Initially
· Line Rate - 2.5 Gb/s (STM - 16)
· Upgrade Possiblity - To 5 or 10 Gb/s
· Overall System Length - 1450 km
· Can Function in Ring Configuration

Survey, burial, and installation are highlighted because they avoid trouble, which saves over the long run. The use of a digital cross-connect system (DCS) simplifies integration with current plesiochronous systems at NA or CEPT standards and will grow gracefully toward a future all-synchronous network.

Since there are no undersea repeaters, we do not require repeater power feed equipment or fault location equipment. Fault location in the cable will rarely be needed, and will be performed by OTDR, electrical TDR, and traditional low frequency test methods.

7. Span Loss Budget

Span loss budgets play an important role in establishing the technical soundness of a system. The longest span of a multi-span system challenges the technology the most. If this span presents sound margins, the shorter spans will be relatively easy. For this reason, we highlight the 225 km Coro-Chichiriviche span in the worst case loss budget shown in Table 5.

The aging margins include allowance for both cable and electro-optics, with cable aging responsible for about two-thirds of the total. The repair margin allows for added cable and splices needed for three repairs over a 25 year life. The end-of-life margin is more than sufficient since the required margin is 2 dB.

TABLE 4

KEYS TO COST EFFECTIVENESS
· Small but tough submarine cable
· Meticulous survey, burial, and installation
· Omitted: Undersea Repeaters & Monitoring, Power Feed Equipment, Repeater Fault Location
· Standard Terrestrial Terminals with Enhanced Line Optics
· Digital Cross-connect System for Add/Drop

TABLE 5

WORST CASE BUDGET - 225 km SPAN	
A. Tx to Rx Min Gain - db	+58.
B. Max Span Loss, dB	50.
C. Aging Margins, dB	2.8
D. Repair Margin, dB	1.6
E. Min Beginning Margin, dB (A-B)	8.0
F. Min End-of-Life Margin, dB (E-F)	3.6

TABLE 6

EXPANDING CAPACITY

	System Capacity
	Gb/s
A. 2 Pairs Equipped	5
B. Upgrade 10 Gb/s per pair	20
C. All Pairs at 2.5 Gb/s	30
D. All Pairs at 10 Gb/s	120

8. Capacity Expansion

Repeaterless systems and systems which use EDFA's (erbium-doped fiber amplifiers) can grow by increasing the line information rate, something which was not possible with earlier regenerator systems. In addition, RED Costera can grow by activating additional fiber pairs which were held in reserve on the first-service date. Table 6 shows the compound effect of these two growth mechanisms. When we upgrade fibers from 2.5 Gb/s to 10. Gb/s we increase capacity by a factor of four, while equipping all pairs at a line rate of 2.5 Gb/s gives a six-fold increase. If we take both routes, we can increase capacity by a factor of 24!

9. Maximum Spans-Current and Future

Table 7 shows the sort of spans which are achievable today, as well as my forecast of achievable spans in 1997. The increased capability will come from: significant increase of transmitted optical power, a limited increase in receiver sensitivity, introduction of off-shore amplifiers with shore-based pumps, and forward error correction. In three years time, some combination of these techniques will be able to provide the 8 dB overall improvement assumed in Table 7.

TABLE 7

Non-Repeatered Optical Systems

Maximum Spans

Bit Rate, Gb/s	'94 Span, km	'97 Span
2.5	260	300
5.	242	282
10.	224	264

TABLE 8

RED Costera - Conclusions

- Thorough surveys, and cable burial - essential to avoid cable failures
- Digital cross-connect equipments can provide drop/add and graceful evolution to all-SDH
- Spare fiber pairs plus line rate upgrade can provide capacity to avoid system obsolescence

10. Conclusion

RED Costera is a prime example of reapeaterless submarine cable technology. It foreshadows an ever-growing number of applications, ranging from single mainland to island links, up to multi-link installations which can serve as a nation's digital backbone. Of the many lessons taught by the RED Costera experience, I have selected three, which I list in Table 8.

Acknowledgements

My deepest thanks to the members of CANTV who worked with Margus toward the realization of RED Costera. Their insight and warmth continue to make this joint effort a source of personal pleasure. Thanks, also to Gus Dodeman who so capably led Margus' contribution. Thanks, too to each and every person who has advanced the submarine system technology to its current advanced position. The contributions of all of these were needed to make RED Costera possible.

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The Importance of Computer Security
to Developing Economics in the Asia Pacific Region

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1. ABSTRACT

As the computer becomes more powerful, faster, smaller and cheaper, organizations have responded with the implementation of complicated telecommunication networks to gain global competitiveness. When the resources of computer and telecommunication networks become indispensable to the functioning of an organization, the adequate computer security become imperative. This paper argues that computer security should be an essential part of the telecommunications infrastructure to support a developing economy.

1.0 INTRODUCTION

Various factors lead to the growth of business to computerise and establish computer networks. Two prominent ones are i) Breakthrough in technology, and ii) Business growth and gaining competitive advantage within the industry.

1.1 TECHNOLOGY

Competition is strong among manufacturers in the semiconductor industry to empower their silicon chips with a high price-performance ratio. As a result, its main product, the computer has seen corresponding skyrocketing performance gain and price reduction.

From 1980-1985, in the US, the average end user price per MIPS (Million Instructions Per Second) fell from US $250,000 to $25,000. From 1986-1990, another ten fold reduction occurred. The average price per MIPS fell from US $25,000 to $2,500. (Rappaport et al, 1991).

In June 1993, "Window Expo 93 Exhibition" in Asia, the escalating competition among Microprocessor-chip vendors to break new ground for its processor speed was evident. In Asia, a PC workstation can now run as high as 150MHz speed[1].

Responding to the new computers on the market that are more powerful, faster, smaller and cheaper, business organizations are buying many of them to automate and share company data to increase their competitive position. In the US, from 1980-1985, the annual per capita in expenditure on computer spending rose from US $90 to US $180 (Rappaport 1991).

1.2 BUSINESS' GROWTH AND COMPETITIVE ADVANTAGE

The new generation of high performance computers when installed with advanced business software, becomes a powerful tool to business. Organizations are quick to identify the niche of using the computer to increase their efficiency, profits and leadership position in their industries.

Technology has created the demand of changes in organizations. Some are radical changes in infrastructure and others are procedural changes in operations. These changes range from automation of operations to policy changes on utilizing and supporting this new computer technology. Using computer technology, production processes accelerate and the quality of the product is enhanced. Electronic mail can transfer memoranda and documents instantaneously, speeding up communications and the approval procedure between the sender and receiver. Point of Sales systems and Automated Teller Systems are capturing data at the place where the transaction occurs. The design department can now send drawings to their vendors over computer communications links. By reducing the turn around time, more time can be devoted to the quality, resulting a general increase of efficiency. In Singapore, by using TRADENETS, commercial documentation is sent from business to the Government organization electronically for processing without the need for physical delivery of the paper copy.

Economics of many developing countries within the Asia Pacific Region have been on the upward trend. The economy has been booming in Malaysia, Singapore, Indonesia and Hong Kong[2]. Many developing nations and their business organizations strive to increase efficiency and competitive advantage by learning from the western countries in deploying advanced computer information systems. China has moved towards modernization and an open-door policy by inviting foreign investment. This has increased the manufacturing of the many computer products and in turn, the demand for computer automation equipment to help the manufacturing process in China [3].

As information and computer technology evolve globally, the world's geographical barriers have now been broken down by the introduction of advanced communication systems like video conferencing, picture-phone and the corporate- wide enterprise network. International wide area networks and digital telecommunications have become more popular over the past ten years , largely due to the standardization of international telecommunication and the implementation of ISDN (Integrated Services Digital Network). With the drive to gain competitiveness, businesses are setting up more complicated telecommunications networks to transfer business data, video, and image to gain time and efficiency on their operations. Many organizations are preoccupied with setting up their corporate networks while ignoring or neglecting the groundwork of computer security on their networks as evidenced in the computer survey discussed below.

2.0 COMPUTER SECURITY

What is Computer Security? Computer security refers to the protection of computing facilities from abuse and disaster to ensure their continuing availability and the reliability of computer-based operations. This includes the protection of both computer hardware equipment and software information.

Computer Security surveys were conducted in Australia in 1986 and in Singapore in 1989 and 1990. The leading 500 business organizations in both countries were surveyed. The results showed that organizations in Australia and Singapore have largely neglected or are inadequate in preventing computer abuse or disaster[4]. There is also a prevalent lack of testing of a Disaster Recovery Plan. Management has largely approached computer security on a "piecemeal" basis, instead of integrating it into the corporate strategic plan, with a specific budget to address the many needs of computer security (Benbow et al, 1986, SIM/RMIT 1991). The following table illustrated inadequacy of computer security in Singapore. It was modelled from the Top 9 Test from Computer Security in Australia in 1986. Similar results were identified from both the Australina and Singapore survey.

Finding from the response questions	%
■ No Security personnel guarding the Computer Centre	58%
■ Never has a fire inspections of computer centres	36%
■ With a Formalized Contingency plan	41%
■ Without a formalized contingency plan	57%
■ Never tested the formalized Contingency plan	49%
■ No identification control in Computer Centre	28%

data from computer survey (SIM/RMIT 1991)

A separate survey was done by Ernet & Whinney in Australia 1988 revealed that 32 % of the 150 respondents feel that security risks have increased over the past 5 years. The profiles of the respondents are ranging from manufacturing companies, to financial institutes and Government organizations.

Vaughan (1993) suggested that many office information systems do not provide the hardware and software access controls necessary to protect information from anyone who gains physical access to the system.

The first line to establish good security of a computing facility lies in the control of access. The Singapore survey showed 58% of respondents did not have security guards and 28% of them did not practice identification control in their data centre. Organizations that allow physical access (free movement) by employees to the data centre, risk the opportunity for the employee-based computer crime. According to the survey, software access control, like read/write access controls to a program or applications are also lacking. The restrictions of unauthorized copying, the promotion of using cipher keys, file encryption and the digital signature are not commonly used. Encryption is a method that scrambles the information such that if it is intercepted, the unauthorized party will not be able to comprehend the information. Ciper keys and digital signature are methods for scrambling and descrambling of message and user's authentication.

With a sophisticated data communication analyzer (computer protocols' data scope), a knowledgeable hacker can record confidential company information including passwords that sent by users of the network. Gaining accessing to a computer network is not difficult when Local Area Network is physically distributed throughout the premises in a company. Plugging monitoring equipment in one of the pre-assigned outlets (Medium Access Unit) can be very convenient and unnoticeable. Worst of all, the non-technical users of the network would have a false sense of security when they are required to log-on and provide their passwords before starting a computer session. Without a general understanding of security, the user is exposing confidential information to anyone who know has the opportunity, the knowledge and the motive to commit a computer crime.

The security problem is potentially higher in developing countries than in industrialized countries. Many business organizations in developing countries have less experience and knowledge in dealing with computer security issues. The advantage of the developing country, however, is that implementation of technology is still largely undefined. Therefore, changes in adapting computer security as an essential part of the telecommunications infrastructure are relatively easier to make than that of the developed countries.

2.1 COMPUTER THREATS

According to Elbra, risks associated with computer facilities include physical and logical threats. Physical threats related to physical assets while logical threats apply to electronic data.

PHYSICAL THREATS: are fire, water, impacts (truck, airplanes), power loss and theft.

LOGICAL THREATS: include systems error, human mistake, fraud, virus, system infiltrations

Source: Elbra 1992

In 1989, 81% of the 98 Chief Executive Officer in the US who responded to a survey recognized that the internal employees constituted a security threat. Suggestions and cases have shown that majority of computer crimes are committed by an internal or an ex-employee of an organization when the person has the motive, knowledge and opportunity to do so. (Benbow 1990, 1992, Baker 1991, Tan 1992, Singh 1992).

2.2 RISK ASSESSMENT METHODOLOGY

There are many risk assessment models available that mostly involve the relationship of risk to the threat, probability of occurrence and impact. Benbow (1993) has suggested a risk assessment methodology that correlates the assessment of security risk on a successive change of control procedure. The method were used within a Bank's Business Unit.

The methodology includes three phases:

(A) *Systems Review and Preliminary Threat Analysis : collects information on the particular application under review and provides a preliminary assessment of where potential threats are evident.*

(B) *Risk Determination : is a detailed assessment and evaluation of identified countermeasures to eliminate the threat from eventuating. This phase will also assess the relative risk of a particular threat occurring.*

(C) *Risk Management : provides for detailed assessment of existing controls and feedback on the mechanism to assess the effect on risk if control procedure were modified. These controls will be costed and it will be possible to identify the cost of control improvement and the effective result on risk reduction if these controls were implemented. The phase also allows for an assessment of existing controls to decide if more cost-effective alternatives can be employed.*

Benbow suggested a Risk Materiality Index (RMI) that will reflect the severity of the identified threat. It will also reflect the impact on the Business Unit, the quality of existing controls and the probability of the occurrence. If existing change controls were changed, the RMI will be recalculated. In such way, the RMI can serve as a relative index measuring the effectiveness of the changes of control procedure.

RMI: Risk is viewed in the context of an event occurring and analyses the derived risk calculation in them to the impacts of the Business Unit. This value is known as Risk Materiality Index (RMI).

RISK MATURITY INDEX (RMI):

RMI= threats x probability x impact

THREAT: Threat is an event that is always able to occur and is influenced by factors outside immediate control. It related to precedent, skill required to realize the threat and the opportunity and ease for threat to occur. Each threat is examined separately and a weighting is assigned. A threat that occurs frequently will receive very high weighting, reflecting the factors of precedent and ease of occurrence. The weighting value of the threat is between 1 and 10 depending upon the significance of the threat to the Bank's Business Unit.

PROBABILITY: The chance the threat will occur in relation to existing preventive control and procedures. The value is between 0 and 1.

IMPACT: Impact is measured in terms of Financial, Client Servicing impacts and Public Image. Financial impact relates to the direct dollar loss or the consequential financial loss that may result if the threat were to eventuate. Consequential losses include litigation cost, investigation cost and recovery cost. Client service impact will address the ability of the Bank's Business Unit to maintain the required services levels to existing clients including any cost that may result from potential loss of customers and any litigation consequence cost to follow. Public Image Impact will consider the effect the threat would have on the public image on the Bank's Business Unit. The principal impact will relate to the influence the threat will have on the ability to gain new clients. The impact will carry an overall assessment of Major, Medium or Minor with a weighting value of 3, 2, and 1 correspondingly.

When the final Risk Maturity Index is calculated from the parameters Threat, Probability and Impact, it can be interpretated according to the following RMI table.

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Risk Maturity index	
0 - 1	LOW
2 - 3	MINOR
4 - 5	MEDIUM
6 - 7	SIGNIFICANT
8 - 9	MAJOR
10 - 30	CRITICAL

2.3 THE IMPORTANCE OF DISASTER RECOVERY

With the introduction of Computer networks and network servers, valuable company information like patents, trade secrets, corporate strategic plans and customer information are now stored in electronic form in a computer information system. Companies have proliferated desktop computers to every employee in the organization. By allowing on-site or remote access of data, this increases the need for computer security.

In a business organization, the ability to recover from a disaster to put the company back to operation quickly could prove to be crucial to the survival of the organization. In a financial institute, if a disaster happens to its data centre, it will affect all the operations involving the use of computers. The company may not be able to update and perform financial transactions. It can also prevent the continuing functions of the company because without computer assistance, the functions and control of the organization can not be carried out. By law, many financial companies must recover from any disastrous event within the stipulated time or the institute may not be allowed to continue its business.

In many public or government service organization, computer systems are used to maintain law and order to direct emergency services where they are most needed. If a computer disaster happens to a utilities' services provider like a telephone company, it may lose all communications from the disaster site to the outer world. Organizations that are dependent on the communication facilities will lose their operating ability. This results may be devastating to the economy and emergency services may be delayed in saving human life.

Much can be learned from the disasters which have occurred in the industrialized countries. Bates (1992) accounts some significant disasters that happened in the US .It is possible that similar disasters could happen in the Asia Pacific Region. Examples of the these disasters include:

- Fire in Hinsdale Central Office - May 8, 1989, fire broke out in a Hinsdale Central Office (CO) which is a major gateway for local, long distance, fibre and cellular services. Fire burned down the CO causing a total disruption of service to over 500,000 customers. Other fire happened in CO included New York City in 1975 & 1987 causing disruption of 170,000 lines and 41,000 lines.

- Earthquake in San Franciso - October 1989, an earthquake with a strength of 7.1 on the Richter scale, which lasted for fifteen seconds, caused the damages in billion of dollars. The bulk of the disruption was due to cables being cut and a consequent loss of commercial power.

- Some 29 natural disasters struck the US in 1989 causing loss of communication services. These included tornadoes, floods, hurricanes and extreme cold weather.

- Error in Software - In 1990 American Telephone and Telegraph, an error in the system signal 7 network has propagated and impaired calls going through the network. In 1991, a similar problem occurred which caused the C&P Telephone Company in Washington DC to have an "outage" of seven hours. This affected ninety percent of the Central Office in three states.

It is important to realize that the more complicated a communication network is, the greater the risk and the more vulnerable the users are if an outage occurs. If a similar disaster happens to the telecommunication facilities in Asia Pacific's developing economies like Singapore, Vietnam, Indonesia, and Hong Kong, it will result to great financial loss affecting the survival of business organizations, devastating the economies, damaging property and even lives may be in danger.

In many developing countries where telecommunications technology is being imported, the concept of disaster recovery protecting the infrastructure of computer facilities and the telecommunication network, has not been fully adapted.

2.4 TELECOMMUNICATIONS BACK UP

When a computer system drives all aspect of an organization's work, its availability becomes crucial to the normal operation of the business. Good telecommunications design and planning can reduce the "outage" of computer facilities caused by failure of telephone lines or communication equipment. With the growth of sophisticated data communication equipment like intelligent network routers, intelligent bridges and automatic switching equipment, communication line outage can be reduced or eliminated by immediately switching over to a pre-planned back up line. There are many ways to recover communication outage due to disasters or sabotage. Three configurations will be discussed.

(A) ROUTE DIVERSITY - As shown in Figure 1, important data between key locations should be connected with more than one path. The paths should be as different as possible.

One path can be on a dedicated telephone line while an alternative path may use a cellular phone line with a cellular modem and MNP 10 data compression and correction techniques. Other alternatives may include the use of micro-wave, infrared communication between buildings, fibre line, or dialup voice line.

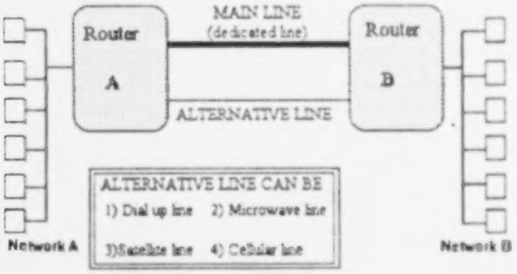

Figure 1 Route diversity

(B) AUTOMATIC DIAL BACKUP MODEM POOLS - as shown in Figure 2, using an automatic dial backup line, a 56K circuit can be backed up with 19.2k or 9.6K modems. The dial backup modems can be activated by a communication controller or an intelligent router upon the loss of the main line.

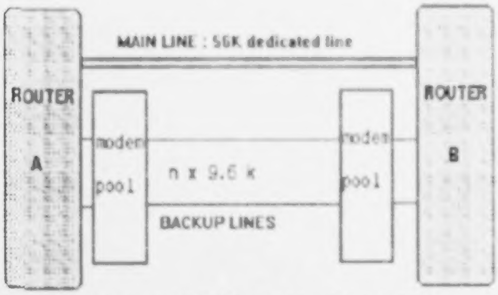

FIGURE 2 Automatic dial backup modem

(C) DYNAMIC ALLOCATION BANDWIDTH ON DEMAND - Figure 3 shows an intelligent network router that can monitor the network traffic. If the throughput over the telephone line is degraded due to heavy traffic, phone line degradation or even failure, a pre-planned procedure can be automatically activated using a dial up modem. It can even dial a pre-programmed paging message to a technician.

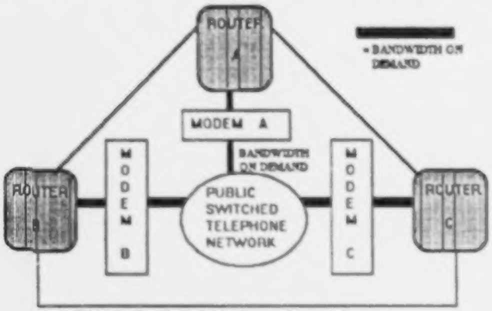

Figure 3 bandwidth on demand

In addition to backing up the communication line, computer facilities can be backed up by using an alternative computer site. An Organization can divide its data processing among different sites. This is easy to achieve with the distributed processing computer network that many companies are using nowadays. Alternatively, professional computer disaster recovery services companies are available. These companies will be able to provide a hot site data centre[3] for rental. Companies should consider the possible use of disaster recovery services and if needed, specify the requirement as part of the infrastructure of the telecommunications facilities.

3.0 TELECOMMUNICATIONS AND ECONOMIES: THE MANY LINKS

3.1 INFORMATION SOCIETY

The rapid advances in merging of computer and telecommunications have produced information so quickly and instantaneously across the world. Industrial countries have led the way to move their economies from industrial capitalism to information-based economies (Akwule 1992 & Sussman et al 1991).

The concept of "Globalization" has been introduced and developed over the last five years. In agricultural societies, economies were based on food production. With the industrial revolution, economies were based on energy to run various machines. Society and people are concerned with the distribution of wealth. The more wealthy a nation is, the more advantage it is over other nations. Nowadays, society has evolved into the information age. Information is like any other asset, with the proper distribution and effective use of information, business and organizations prosper. In turn, this generates a prosperous economy. As in wealth, information can be a medium for exchange of power and profit if it is used effectively and in a timely fashion.

In the 1990s, leading developing countries like Taiwan, Singapore and Korea, and the city of Hong Kong are moving towards the post industrial era, where economies are affected by information. Business organizations and government perform their duties by receiving, accessing and acting on information. The quicker, the more accurate, the more complete the information is, the higher the chance that a decision can be made to manage the state of the economy. Telecommunication has provided the infrastructure to transport information. Computers have created and processed information so quickly and massively that information is now a commodity that can add value to our lives.

As quick distribution of information reflects an advantage of one nation over another, the new era of information underlies the importance of timely distribution of information among countries in the world. Industrialized countries are well versed in the utilisation of high technology and training to make use of the information. Information is as an asset. It is valuable and it can be used to help in making profit for an organization. Some developing and third world countries are still in the industrial era, struggling to modernize their production process. They are still struggling in the Information Technology revolution. Networks that some developing countries are building may require long term strategic plan and support. Computer security in the network in developing countries could range from very crude to sophisticated type that modelled from those in Multi-National Corporation.

3.2 LINK BETWEEN TELECOMMUNICATIONS AND A DEVELOPING ECONOMIES

Telecommunications and development of economy are linked in many ways. Some of these ways are discussed below

3.2.1 LINK: TELECOMMUNICATIONS DENSITY

In Asia Pacific and Oceania, industrialized countries like Japan, New Zealand and Australia, are among the highest densities of telephone line per capita in the region. This is followed by city of Hong Kong, and some developing countries like Singapore, Korea, Malaysia, Thailand and Indonesia. Generally, the more extensive the telecommunications networks, the faster the pace of information dissimulation. Based on the above table, it appears that generally, the higher the density of the telephone main lines per 100 capita, the higher the Gross National Product per capita. Further research will be required to confirm if this is a causal relationship.

Economy	Countries	Telephone density: lines / 100 Inhabitants	GNP: US$ per Capita
Industrialized countries	Japan	43.82	23,820
	Australia	47.32	17,412
	New Zealand	42.86	12,464
Developing Countries	Singapore	38.67	11,694
	HongKong city	41.76	10,266
	Korea	31.52	5,593
	Malaysia	8.88	2,373
	Thailand	2.32	1,415
	Indonesia	0.60	580

(Source:AEUno.3/1993 Asia-Pacific:Basic indicator 1990)

3.2.2 LINK: TELECOMMUNICATION TRAINING

Over the last three years, there has been a growth of importing telecommunications training from developed countries to developing countries. Hong Kong has campaigned abroad for technology lecturers in 1990-1992. City Polytechnic, Colleges and Universities in Hong Kong were expanding their Data Communication courses. Developing countries have seen expatriate lecturers coming from UK, Canada and United States to Singapore and Hong Kong. Industrialized Countries like Australia and UK and US also offer offshore training programs in both the undergraduate and post-graduate programs in Information Technology or Telecommunication[6].

3.2.3 LINK: CHOICE OF TECHNOLOGY

There has been an increase in advanced telecommunication equipment technology availability in Asia. Advanced network communication routers, Local Area Networks, Wide Area Networks, FDDI, Frame relay, ATM technology and ISDN have all been introduced to Hong Kong and Singapore. Taiwan has been testing ISDN and plans to introduce commercial ISDN services in 1994. Wireless cellular networks have been growing in Asia. Satellite service will be increased as Hong Kong AsiaSat 2 schedule to launch in 1994 covering Hong Kong, Taiwan, China and Korea. Measat (Malaysia) will be launched in 1994. KoreaSat will be launched in 1995 and Thailcom 1 & 2 schedule to launch in 1993 and 1994. However, VSAT technology has not been significant in Singapore and Hong Kong as the geographical span of the country is small.

3.2.4 LINK: MANAGEMENT OF TELECOMMUNICATION

In many ways, there is still a great need for management personnel who can understand the rapid change of technology and can manage it in relation to the business needs of the organization. The rapid deployment of communication networks has not been accompanied with the increase of trained personnel with expertise in computer security and in the area of disaster recovery.

3.3 COMPUTER SECURITY IN GROWING ECONOMIES

In Singapore, Australia and Hong Kong, telecommunications networks have helped change these countries towards an information society. People's lifestyle, their living and working condition are all dependent greatly on the continuing effective operations of the telecommunication networks.

Automated Teller machines; Mass Transit Railways in Hong Kong and Singapore; cellular telephone technology; wireless electronic capture of car toll payment system in Singapore, airport traffic control systems; telephone bank account enquiry and transaction transfer; "credit card shopping" and "debit card shopping" in Singapore are a few of these examples. People rely heavily on the computer and communication system. They expect it to be operational 24 hours a day. Should a computer abuse occur on these facilities, like virus infection, computer crime, a disaster happening to the computer site or its telecommunication equipment, then, business, social and economic activities will suffer greatly. In the case of disasters, building properties or human lives may be lost. The continuing deployment of telecommunication networks and computer technology has increased the importance of computer security to ensure the continuous and reliable availability of computer and communications facilities.

4.0 FUTURE OF TELECOMMUNICATIONS AND COMPUTER SECURITY

The trend of using computers and telecommunication network will continue in the next decades. There will be a convergence of more powerful computers with higher bandwidth telecommunication facilities. The economy will emphasize more and more instantaneous and global accessibility of information. People in society will find more ways of applying computer and telecommunication to enhance their life-styles. Electronic newspaper with multi-media presentation will be available to those who have connection to high bandwidth telecommunication facilities. High definition television will also be available commercially. (Bearman 1992, Clutterbuck 1989, Sussman and Hamilton 1987)

4.1 THE DEVELOPING COUNTRIES

For the majority of the developing countries in the Asia Pacific region, the priority will be to increase the telephone main line density throughout the countries. This is especially important to countries with less than one main line per one hundred inhabitants. If the telecommunication network is not built, the global distribution of information will not be broadly used or distributed quickly enough for business and government organizations to take any competitive advantage. The more and faster the information received by a country, the better its ability to achieve to a prosperous economy, a competitive advantage and leadership position among competitors.

4.2 FUTURE OF COMPUTER SECURITY

Computer technology with cheaper, better and more powerful functions will be increasingly used in telecommunication equipment. Artificial intelligence technology especially knowledge based system, pattern recognition technology, neural networks and frame based diagnostic systems will be used to monitor and review network irregularities. These will make it possible the automation of computer security monitoring and auditing on the telecommunication network. Knowledge based expert systems will be able to "self-learn" the activities and recognize patterns of transactions within the network. An expert system in the US is already being used to monitor the million dollars of share transactions daily. Networks will continue to grow in a distributed processing environment. "Intelligent building" will be designed with advanced high bandwidth information utilities. A centralized security system can be set up to monitor the physical threats, like control access, fire, water, power and equipment failure. Voice, data and image are all integrated with route diversity, and with redundancy of equipment and power facilities (NCB, 1992). An intelligent building is ideal to set up a computer security system through out to protect the lives, information and facilities inside the building.

4.3 CONCLUSION

As much as computer and telecommunications technology have provided the structure for us to evolve to the information society, people are still vulnerable to computer abuse, disaster occurrence in natural, accidental or deliberate act of aggression.

For the developing economies, a lot still needs to be done to share the information that is vital to their competitive advantage, economies and the discharge of government duties. To achieve this objective, international cooperation and regional collaboration must be part of a larger economic and information technology system. The demand of trained personnel with computer security skills will become a necessity to the economic system. Computer security must be part of the governement and corporate's telecommunication infrastructure. Developing countries that are still building the countries' telecommunication structure will have the opportunity and challenge to incorporate computer security as an essential part of the telecommunication structure aim at supporting the countries' economies.

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NOTES:

1. Window Expo 93 in Singapore, Intel© announces its platinum processor runs at 60 Mhz. Digital© announces its Alpha AXP 21064 supercomputing processor that runs at 150MHz.

2. Gross Domestic product in US$/Capita: Singapore: $11,694, Hong Kong: $10,266 Malaysia: $2,373

3. China now produces book-size computer in Shenzhen, many computer peripherals like video cards, communications cards are produced in China.

4. The standard of computer security was determined by using the Top Nine Test. This test was devised by Gary Benbow, Jason Masters and Barry Cooper in 1986. In the Australia security survey 99% of companies surveyed received unsatisfactory or below rating while the figure in Singapore security survey was 98%.

5. A "Hot site" is a facility in a disaster recovery service company. It is fully equipped with a telecommunication systems and computer facilities, ready to use in a short-term notice. Full environments and systems are in place, and the customer merely moves his people in and begins disaster recovery.

6. Australian universities include Monash University, University of Central Queensland, Royal Melbourne Institute of Technology, University of New South Wales . UK universities include University of Sheffield, University of Hallam.

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MEXICO'S DRIVE TOWARD A FIRST WORLD TELECOM INFRASTRUCTURE AND EDUCATION

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ABSTRACT

In the last four years, Mexico's telecommunications have grown strongly, resulting in an increase in the modernization of its telecommunications networks. Perhap the most remarkable development of all is the speed at which this transformation is ocurring. This paper presents the most important Mexican advances in the areas of telecommunications. We also include, our analysis and expectatives about the near future of the telecommunications in Mexico with special emphasis in human resources development.

I. PROGRESS AND ECONOMIC SCENARIO

Since 1988 to date, Mexico's economy has suffered a complete transformation which has permitted it, in less than five years, to jump from the 25th to the 13th position among all the world's economies. In this period, Mexico has triplicated its exportations to the United States reaching the $40 billion dollars. With the signature of the North American Free Trade Agreement (NAFTA), Mexico will be able to participate in a more than 360 million customers market, with an annual sales potential of 6 trillion dollars, 25% bigger than the European Economic Community expected market [1].

Mexico's annual inflation rate has diminished from 159% in 1987, to an expected 9.9% in 1993 with a declining tendency, seeking to reach an inflation rate similar to those of the United States and Canada. On the other hand, after a 10 year period, Mexico presented in 1992 a 2% GNP surplus on its public finances, mentioning as reference that in 1987 it had reached a maximum public deficit of 16.1% of the GNP.

Mexico, as most of the Latinamerican countries, is trying to modernize its telecommunication infrastructure. The country's modernization efforts on telecommunications have demanded large investments, which are being financed with the participation of the private industry.

Within such a modernization process the Government's role was redefined, establishing that it was not required to be an owner State in order to guide the telecommunications development. Instead, it is taking a regulating role in the juridical framework within the modernization process of Mexico's telecommunications. It can then be established that during the 1989-1993 period, a radical transformation has happened in the organizational and juridical framework of Mexico's telecommunications, emphasizing among others, the following aspects:

-The Communications and Transportation Ministry (SCT) has strenghtened as a regulating body only.
- A new telecommunications' regulation has been put into effect.
- Teléfonos de México (TELMEX), the formerly state owned public telephone company is now a private enterprise.
- Competition for new telecommunications services in Mexico is promoted.
- Foreign investment is being promoted by allowing up to 49% ownership of telecommunication companies.

All the changes carried out in this period, have shown in a direct and immediate way in several new and important developments in Mexico. Up to date, about a million new telephone lines have been installed, and the telecommunication services have been modernized with the massive introduction of digital technology, optical fibers, cellular mobile systems, etc. On the other hand, by the end of 1993 Mexico will count with a new generation of domestic satellites which will offer C, Ku and L frequency bands, where the L band could be used for rural and mobile communications.

II. FIVE YEAR PLAN OF MEXICO'S PUBLIC TELEPHONIC NETWORK .

As a result of its September 1989 privatization, Teléfonos de México S.A. de C.V. (TELMEX) established a five year strategic plan, aimed to modernize the Mexican telephone network.

After four years of initiation of TELMEX's strategic plan, the main achievements obtained to date have been [2],[3],[4], [5], [6]:

* It has passed from a 6.5% telephone density in 1990 to one of 9.1% in1993.
* A total of 7.5 million installed lines by the end of 1993, 44.5% more than the lines installed before 1990.
* The digitalization index of the telephone plant as a whole passed from 29% to 60% between 1991 and 1993, replacing 470 thousand lines from obsolete electromechanical switching centers.
* There are 10 international traffic centers in the country, from which traffic to others countries is handled through more than 12,300 circuits.

- Until 1991 the installed long distance system had a total of 68.5 millions of kilometers-circuits, increasing the long distance calls in a 12.3% and the international calls in a 21.7% in relation to the previous year. In 1993, 57% of the long distance system operates with digital technology. The complete digitalization of the long distance switching centers is expected by 1995.
- Presently there are over 15,000 leased lines in service, 80% of which are digital. This type of circuits has been in a great demand, particularly for data transmission.
- The recent introduction of Synchronous Digital Hierarchy (SDH) technology in digital transmission systems.

According to its strategic plan, TELMEX expects that by the year 2000, it will pass from almost 7 millions of telephone lines installed in 1992 to a minimum of 15 millions, and from a density of 7.81% to one of approximately 16 % in the same period.

Besides that, TELMEX has advanced in the construction of a 13,500 kilometers backbone for a national optical fiber network, which is pretended to intercommunicate Mexico's 56 main cities. This network is already operating in some of its segments, overall operability is scheduled for the beginning of 1994 [7]. In the mean time, TELMEX has already finished the installation of this network in all the border crossings with the United States (fig.1).

Under the same philosophy of modernization, TELMEX is expecting to finish the installation of submarine optical fiber wiring, which will increase Mexico's digital connecting capacity with other countries.This project, called Columbus II, will permit TELMEX to count with a capacity of 23,000 circuits in its transatlantic segment, with tie points in Cancún, Florida, Saint Thomas, Canarias Islands and Palermo. The Columbus II project will permit TELMEX to satisfy its international telecommunications demand from now until the year 2010. Expected date to start operation is at the end of 1994. The Columbus II will have a capacity of 18 to 24 optical fibers, its length extension will reach approximately 13,605 kilometers, and will operate to a transmission speed of 565 Mbps by each pair of fibers.

As an important complement to all above, TELMEX has a special interest on the advanced and added value services, the major efforts of trading are pointed toward the Integrated Digital Network, Satellital Network and Private Circuits. With the Integrated Digital Network functioning in more than 30 cities of the country, it counts with access facilities directly from the users addresses, by systems of optical fibers and microwaves, that permit the transmission of voice, data and image in a simultaneous way. To complement the coverage of this network TELMEX has in operation the Multiuser Satellite Network, with a coverage to all the Mexican Republic, United States, Central America and the Caribbean, through the Morelos satellites' Mexican system and soon the Solidaridad satellites [8].

TELMEX is expecting for 1995, to be able to initiate pilot tests of wideband services as video-conferences, high definition television and multimedia communication, through the use of the Asynchronous Transfer Mode (ATM) technology.

III. TELEPAC MEXICAN'S PUBLIC PACKET SWITCHING DATA NETWORK

TELEPAC public switching data network (PSDN), unlike other countries' communication packet networks, as TYMNET, TELENET and BITNET networks of the United States, has been scarcely used as a backbone of local area networks. The main reasons are, among others, the great time delay, and the high nodal process (detection and correction of errors) in each linkage point of the network, the orientation of network service which has no capacity to manage burst traffic, typical of local networks, and to the inadequate capacity of TELEPAC to sustain higher transmission speed and wide bandwidth, which has caused jams and bottleneck congestions as the network traffic increases.

There is a great Federal Government interest conducted by the Mexican Institute of Communications (Instituto Mexicano de las Comunicaciones, IMC), and the Technical Office of TELECOMM (Telecomunicaciones de México) to give an impulse to the development and modernization of TELEPAC network, as well as for the demands of potential customers from Mexico, United States and Canada with the need to use a high capacity and faster backbone network.So the IMC asked CICESE to carry on a study regarding with the feasibility of the Mexican PSDN TELEPAC modernization.

FEASIBILITY ANALYSIS FOR THE APPLICATION OF THE TECHNOLOGIES FRAME RELAY AND FAST PACKET TO THE MEXICAN TELEPAC PSDN.

The new technologies of Frame Relay, Fast Packet Switching and Streamlining Transporting Protocols, which as a group provide a fast communication network for the transmission of data are proposed to make TELEPAC a fast commutation network, with the capacity to manage applications such as: the interconnectivity of local network data, wideband range requirements of image and graphs processing, heavy transferring of files between microcomputers, computer aided design, etc.

One of the important characteristics of frame relay, and which presents a favorable advantage for the TELEPAC network, is its capacity to coexist in a hybrid environment; this means it can continue using the X.25 technology in those places and/or paths of TELEPAC network which could be required, and to apply the frame relay technology in those links with enough demand and which fulfill the quality of the lines required for frame relay. This gives as a result, that the TELEPAC network can in a gradual manner obtain the quality mentioned, according to requirements of growth.

The analysis of reliability to convert TELEPAC to a frame relay network, was analyzed taking into account [9]:the access equipment associated to the network (CPE or Customer Premise Equipment), the switching equipment in the backbone, the physics lines used in the path, as well as the network's own topology, establishing also a series of lay outs related with the administration of the network (fig. 2).

The main recommendations of our study state the development of the TELEPAC network in three stages:

Stage 1: Passing in a gradual manner from X.25 to Frame relay.

Stage 2: To coordinate in this stage The Frame Relay technology with Fast Packet Switching technology.

Stade 3: To fully develop a SMDS network.

Through the first stage it can achieve carrying out the national and international LAN's interconnectivity; this means that it could exclusively support data traffic . In the second stage it can include the services of voice, data and images. Finally, in the third stage it can provide complete service of high speed and multiplexing.

IV .MEXICAN SATELLITE COMMUNICATION SYSTEMS: EXPANSION OPORTUNITY

HISTORICAL BACKGROUND

The first two domestic geosinchronous satellites of Mexico, Morelos I and Morelos II, were launched in June and November 1985, to take orbital positions 113.5 W and 116.8 W respectively.
Both satellites are identical, having been the first of this series to operate on the C an Ku bands, with an expected lifetime of 9 years, (see table I.)

In 1994 Morelos-I will get to the end of its usefull lifetime, situation that urged the SCT, Telecomm and the Mexican Institute of Telecommunications (IMC) to specify the next generation of mexican satellites, namely Solidaridad I and II [10].

Among the mayor advantages of the Solidaridad satellites over the Morelos are: Three-axial stabilization, 2500 total transmit power (800 on the Morelos), threefold Ku band capacity, introduction of L band for mobile services,and C band coverage spanning from southern USA to Chile (see table II) (fig 3). Solidaridad satellites will be put into orbit in November 1993 and February 1994, to positions 109.2 W and 113 W [11].

FUTURE PERSPECTIVES.

Mexican Satellite Systems Design:
From the inception of the negotiations to acquire the Solidaridad satellites, a program was furnished to specialize a group of mexican researchers on satellite design and construction, with the objective that in the third generation of satellites which will substitute the Solidaridad system, some subsystems of the satellite will be designed and possibly built by this team. The specilization program is presently beeing carried out by two subgroups, one working within Hughes Aircraft Co., and the second through postgraduate studies in UCLA, USA.

Experimental Satellite Desing and Construction:
A group of mexican research institutions are working on the project SATEX, with the objective to design and build an experimental low orbit satellite. The satellite will have an aproximate weight of 50 Kg., with a primary communications payload working on the UHF band, Ka band and infrared band for optical communications; besides, a CCD camera for low resolution imaging. The first prototype, SATEX-1 will be launched by Arianespace Inc., in mid 1994 [12].

V. COMMUNICATIONS IN THE MEXICAN RURAL ENVIRONMENT

Rural communications have been a matter of permanent importance and preoccupation for the Federal Government since some years ago, and although it succeeded in achieving some penetration of services in the last two decades, it is starting from 1990 that really have obtained meaningful advances both in coverage, and in the improvement of communication services in the Mexican rural environment.

Historical Background. In 1970 there were 95,400 towns with less than 2,500 inhabitants, gathering a total of almost 15 millions of people. In 1978, 2,700 of these locations counted with telephonic service provided by TELMEX, corresponding to a 2.8% of the total of rural settlings, while the rate of integration of towns to the public telephone network was 300 per year.
Because of the low telephonic penetration in the rural environment, in 1979 the SCT elaborated a technical-economic strategy named National Plan of Rural Telephony (PNTR), with the objective of providing telephone communication to 13,255 locations with 500 to 2,500 inhabitants in a period of 6 to 10 years [13].
The implementation of the PNTR gave as a result partial achievements, in such a way that in 1990 with 153,800 locations smaller than 2,500 inhabitants, totalling 21 millions inhabitants, there were 8,109 rural locations attended by TELMEX (fig 4) [14].

Rural Communications in the 90's. Starting from 1991 Regional and National actions, have been performed that assure a remarkable improvement in the expansion of the communications in the rural environment, being the agents of this improvement TELMEX and the governments of some states of the country. Nevertheless, as it will be evident in the description of these projects, there isn't a master plan to coordinate these agents.

TELMEX Compromise. As a result of TELMEX's concession renewal by the Federal government, one of the compromises TELMEX acquired for the 1990-1994 five year period, consists on getting that all the towns with more than 500 inhabitants, according to the General Census of Population and Housing 1990, have access to the telephonic service, at least by a public booth or a long distance service agency. This means to incorporate to the public network about 6,700 rural locations by the end of 1994 [15].

State Rural Networks. Since 1991 some state governments have established their own satellital rural networks, using their own criteria and resources. Due to the fact that there isn't a master plan, these state networks are incompatible with each other. Next, there is a description of the main characteristics of each one of them [16].

SONORA's RURAL TELEPHONE NETWORK. Started operation in march 1991. It's a pre-asigned FDMA-SCPC star network, with the hub located in Hermosillo (capital city) and initially 15 remote terminals in selected rural locations. Transmition is on C band of the Morelos satellite with variable digital rates multiplexed on a 64 kbps standard channell. This network is stretched out through 8 multiple-access radio systems located on 8 remote satellite terminals, with the target to cover 117 locations on this stage.

OAXACA's RURAL NETWORK. The second statewide system started operation in december 1991. It's a star topology network with ten rural nodes and a hub collocated in Oaxaca city. It uses TDM/TDMA for outbound/inbound channells, transmitting at 256/192 kbps rates on the C band. The next step in their expansion plan is to use multiple-access radio system in some satellite terminals.

BAJA CALIFORNIA NETWORK. Unlike the two former networks owned by the state governments, the satellite rural network of Baja California is being deployed (1993) by the local public telephone network (PTN), TELNOR. The rural terminals are going to be a section of a wider urban network planned by the PTN. This is a more flexible satellite system using SCPC-DAMA, with 64 kbps channells which can carry multiplexed sub-channells at various data rates. It follows a star topology with 9 rural nodes transmitting on Ku band.

Perspectives.

Combined to all above, actions of other mexican institutions will contribute with new elements in order to increase the rural coverage. Nevertheless, there is still the need of a general coordinator who defines the strategy and leads the efforts appropriately, with the purpose of obtaining bigger benefits and efficiency of the investments. Under this situation, a series of actions have been developed tending to strengthen the rural communications in Mexico. Such actions and institutions are:

a) Feasibility Study for the use of European Rural Satellite Equipments in Mexico. The Instituto Mexicano de las Comunicaciones (IMC) asked CICESE to evaluate three VSAT systems of rural application made in European countries, foreseeing the possible introduction of a satellite rural system with national coverage [16].

b) **OEA-IMC Study.** The OEA and the IMC finished in 1993 the project "New Communication Technologies Applied in Social Interest Zones". This project is seeking the application of new communication technologies to extend the possibilities to communicate the rural area [14].

c) **CICESE.** The satellite communications research being developed at CICESE on the area of VSAT networks, investigates the possibility to use random access protocols for voice communications in rural systems.

d) **TELMEX.** The Telmex concession title enforce it to plan along with the SCT, expansion programs for rural telephony every 4 years.

VI. MEXICO's TELECOMMUNICATIONS HUMAN RESOURCES EDUCATION

As stated before, Mexico, like the international community, is paying more attention to the telecommunications developments. The world's telecommunications industries forecasts for the year 2000, are to reach 2 billions dollars worth; of which, 48% will correspond to the telecommunications services, 12% to the telecommunications equipment support, and the 40% to the acquisition of informatics systems. Under this expectancies, one of the most importants milestones to support such developments, is without doubt the telecommunications high academic level of the human resources. At the present there are almost 70 institutions of high level education in Mexico, which offer the telecommunications engineering specialization, or the electronics engineering career with branches in some telecommunications field. In global terms, the annual average of graduated telecommunications students is around 2 thousand, adding up to total of nearly 25 thousand telecommunications engineers [17].

Neverthless the relatively high annual rate of graduated students in telecommunications area, this situation changes drastically at postgraduate level, because only four academic institutions in all of Mexico offer a masters degree on this area, and only three of them have doctoral studies (CICESE among them). The annual graduation rate of master degree students is less than 15 in the telecommunications area, but of more concern is the average of graduated students as Ph.D., of only one per year. Besides, the number of graduated Mexican students (as M.Sc. or Ph.D.) in the foreign education institutions in telecommunications is also very low , out of which up to a maximum of six per year get back to Mexico, including M. Sc. and Ph.D.

The telecommunications scientists including all the Mexican research centers and universities are approximately 50, but a high number of them are migrating to the Mexican industries or telecommunications service companies.

For all above, and considering the expected requirements of human resources in the telecommunications area, in the short term, in one side caused by the internal development of the telecommunications industry; and on the other side, because of the great requests of telecommunications services as a result of the possible economic integration of Mexico with Northamerican economies, the situation turn specially critical. Considering both aspects, the requests of human resources for telecommunications in Mexico, would duplicate the actual number of engineers in this area, presently over 25,000 to approximately 40,000. It would be necessary to increase the number of postgraduates in the area, it means from 15 to 150 annual postgraduates.

In reference to the support of the telecommunications research groups, they must be increased from 4 to 10. Besides, it is necessary to make a redistribution of human resources in telecommunications through the country, because 80% of them are concentrated in the central part of the country.

There are several plans, opinions and recommendations planted by international organisms as the ITU, which in its declaration in Acapulco 1992 recommend, to countries like Mexico, about the human resources: "to impel the development of the institutional structure and human resources, to ensure the everlasting development of the infraestructure of telecommunications to guarantee the efficient work and service quality", as well as a colegiate engineers, consultors, experts, researchers and teachers [18], [19].

Unfortunately, at the present there isn't a master plan to coordinate all the ideas, opinions and recommendations above planted (among others). We think it is very important to resolve this situation, in order to create in a relatively short period, a master plan that could coordinate adecuately the Mexican's telecommunications education and research tasks.

CONCLUSIONS

As stated in this paper, Mexico's telecommunications have had a development without precedents in the last five years, through the modernization of most of its communication systems, introducing in a high percentage the digital technology. Such modernization has been motivated mainly by the Federal Government interest to reach higher competitivity, appealing to the development of new and better telecommunication services, establishing for this porpouse a regulatory framework of telecommunications services much more flexible, according to the requirements of a wider trade opening; and above all, redefining the Government's role as a regulating agent and not as an owner of the country telecommunications, being the main example, TELMEX's privatization.

According to all above, the telephone public network is growing adequately in agreement to a quinquenal plan that has permitted it to modernize, improve and offer new services.

In the same way, by the end of this year, Mexico will put in service the second generation of mexican satellites, with new and better characteristics than the former, with new services and a coverage of most of the American continent. By the other hand, the switching public network of data packets is also being modernized adapting to the new technologies of Frame Relay and Fast Packet Switching with the purpose of being a solid alternative as Mexico's high capacity backbone in the present decade.

However, there still are many challenges to face. The lack of a clearer definition and a regulating plan to solve the problematic associated to rural communications, to human resources formation and to the strengthening of the country's research groups in the telecommunications area. We think this is the most important matter to attend, we feel that it is not possible that the growing and development of the telecommunications happen only in some aspects, without giving the same importance to the rural sector, and mainly the constant formation of human resources with higher quality and training in the new technologies, as well as the propping-up of the telecommunications research groups of the country. As it was said before, there are many accurate ideas to solve this, but not materialized in a regulating plan.

Finally, we have advanced adequately in Mexico's telecommunications development, but there still is too much work to do, we think Mexico's telecommunications are in the right way, but quality and efficiency have to be improved as well as the upcoming telecommunication services. It is a challenge and an opportunity that is worth to face to improve the telecommunication systems, from a service, social, scientific and academic point of view in Mexico.

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Table I. Technical Characteristics of the Morelos Satellites.

Frecuency Band	C (Narrow)	C (wide)	Ku
Number of transponders	12	6	4
Band width	36 Mhz	72 Mhz	108 Mhz
TWT power	7 W	10.5 W	20 W
EIRP	35.5 dBW	38.5 dBW	44 dBW
Up-link frecuency	5.9 - 6.4	5.9 - 6.4	14.0 - 14.5
Down-link frecuency	3.7- 4.2 Ghz	3.7- 4.2 Ghz	11.7-12.2 Ghz
Coverage	Mexico	Mexico	Mexico

Table II. Technical Characteristics of Solidaridad Satellites.

Frecuency band	C (narrow)	C(wide)	Ku	L
Number of transponders	12	6	8	1
Band width	36 Mhz	72 Mhz	54 Mhz	29
TWT power	10 W	14.4 W	42.5 W	21 W
EIRP	37.5 dBW	40.5 dBW	47 dBW	45 dBW
Up-link frecuency	5.9- 6.4 Ghz	5.9- 6.4 Ghz	14.0- 14.5Ghz	1.52 Ghz
Down-link frecuency	3.7- 4.2 Ghz	3.7- 4.2 Ghz	11.7- 12.2 Ghz	1.629 Ghz
Coverage	R1,R2,R3	R1,R2,R3	R4,R5	Mexico

R1	Mexico, Souther USA, and Norther parts of Central America
R2	Mexico, Central America, Caribbean, Venezuela and Colombia
R3	South America and western Brazil
R4	Mexico, Southern USA and San Francisco
R5	Key U.S., cities and a small fraction of Canada

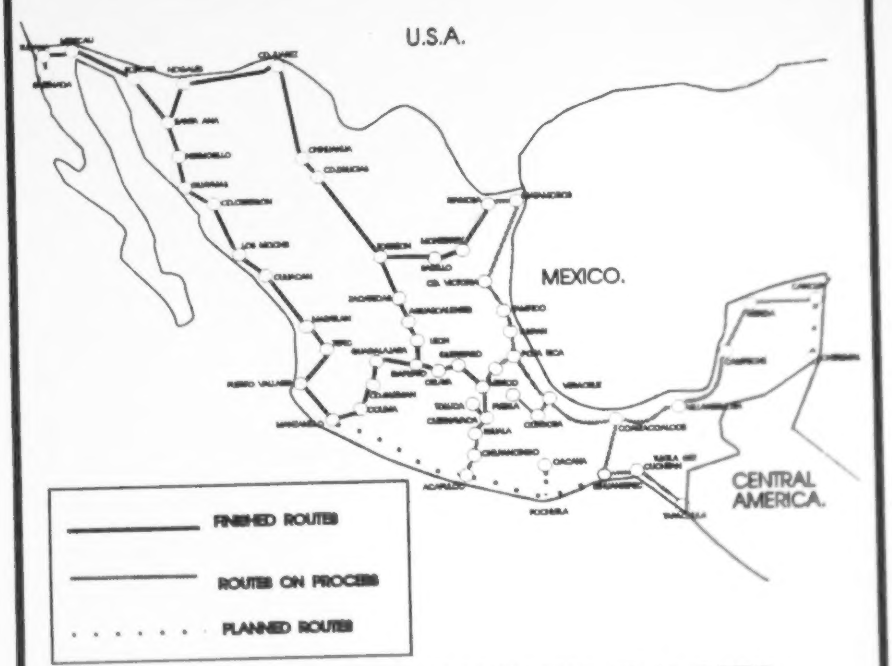
U.S.A.
MEXICO.
CENTRAL AMERICA.
TIJUANA
MEXICALI
ENSENADA
NOGALES
CD. JUAREZ
SANTA ANA
HERMOSILLO
GUAYMAS
CD. OBREGON
LOS MOCHIS
CULIACAN
MAZATLAN
TEPIC
PUERTO VALLARTA
MANZANILLO
GUADALAJARA
COLIMA
CHIHUAHUA
CD. DELICIAS
TORREON
MONTERREY
SALTILLO
REYNOSA
MATAMOROS
CD. VICTORIA
ZACATECAS
AGUASCALIENTES
LEON
QUERETARO
IRAPUATO
CELAYA
TAMPICO
TUXPAN
POZA RICA
MEXICO
TOLUCA
PUEBLA
CUERNAVACA
IGUALA
CHILPANCINGO
ACAPULCO
OAXACA
CORDOBA
VERACRUZ
COATZACOALCOS
VILLAHERMOSA
TUXTLA GTZ
TAPACHULA
CAMPECHE
MERIDA
CANCUN
CHETUMAL
FINISHED ROUTES
ROUTES ON PROCESS
PLANNED ROUTES

FIG. 1 TELMEX NATIONAL FIBER OPTIC

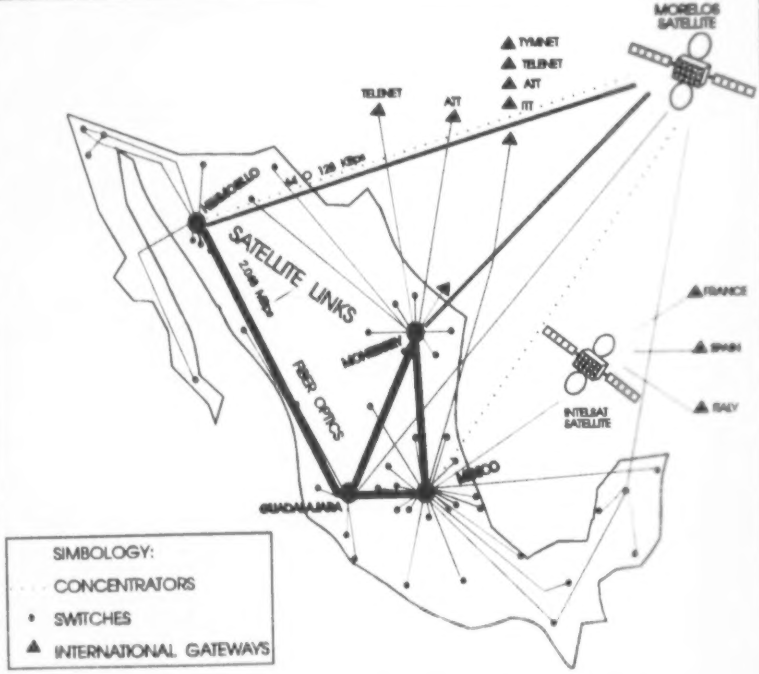
MORELOS SATELLITE
TYMNET
TELENET
ATT
ITT
TELENET
ATT
64 O 128 Kbps
HERMOSILLO
SATELLITE LINKS
2.048 Mbps
FIBER OPTICS
MONTERREY
GUADALAJARA
MEXICO
FRANCE
SPAIN
ITALY
INTELSAT SATELLITE
SIMBOLOGY:
CONCENTRATORS
SWITCHES
INTERNATIONAL GATEWAYS

FIG. 2 FIRST STAGE FRAME RELAY BACKBONE PROPOSAL FOR THE MEXICAN PSN TELEPAC

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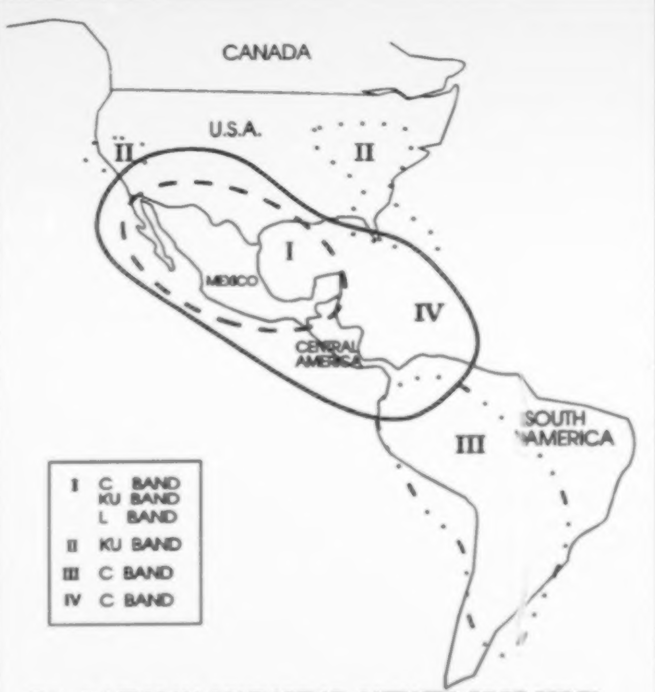
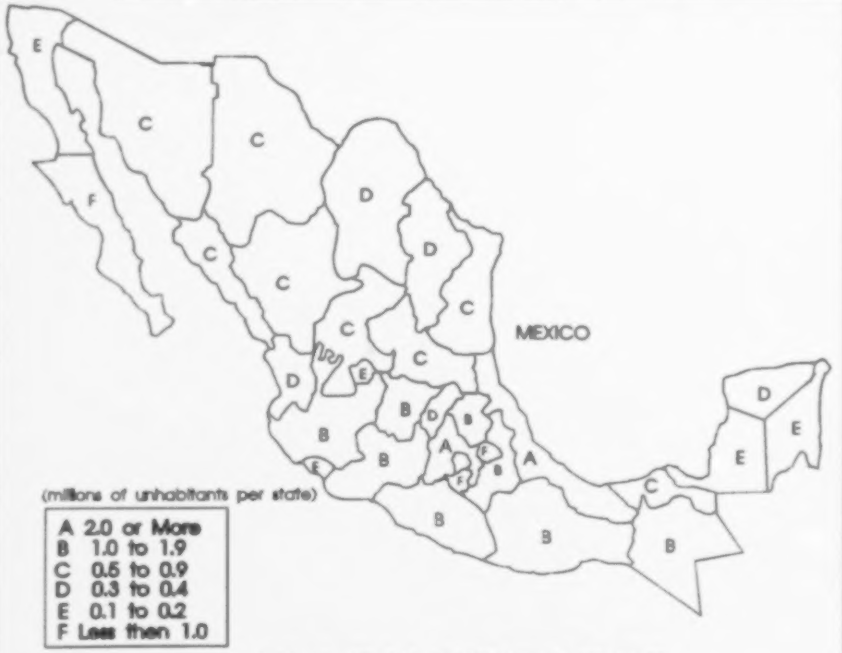

CANADA
U.S.A.
II
II
I
MEXICO
IV
CENTRAL AMERICA
SOUTH AMERICA
III
I C BAND
KU BAND
L BAND
II KU BAND
III C BAND
IV C BAND

FIG. 3 MEXICAN SOLIDARIDAD SATELLITES FOOT PRINTS (INCLUDING, C, KU AND L BANDS)


MEXICO
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B
B
B
C
D
E
E
B
(millions of unhabitants per state)
A 2.0 or More
B 1.0 to 1.9
C 0.5 to 0.9
D 0.3 to 0.4
E 0.1 to 0.2
F Less then 1.0

FIG. 4 RURAL POPULATION IN 1990

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THE DEVELOPMENT OF VALUE-ADDED VIDEO SERVICES IN THE PACIFIC REGION

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1. ABSTRACT

The recent expansion of TV broadcasting markets in Asia, and the trends towards deregulation in areas related to satellite transmission services, has provided an opportunity for the development of a new, value-added service in the Region. In collaboration with KDD, the Japanese international carrier, Keystone Communications created "K2-Skylink" in early 1992 - a service which in its first two years has provided transPacific transmissions for a growing list of terrestrial and satellite broadcasting organizations, in Japan, Hong Kong, Korea and Taiwan as well as in North America. At first, the user community was sceptical of the advantages offered by the service; and many of the national telecommunications administrations were reluctant to move into an unfamiliar business area. However, real progress has been made and there are now plans to expand the service to reach other countries in the Pacific Rim.

2.1 DEFINITION

K2-Skylink is a transPacific satellite transmission service for broadcasters and other video users requiring occasional or contract services. The name comes from the initial letters of the two organizations which created the service - KDD and Keystone.

2.2 HISTORY

The origins date back to 1984 when the Japanese networks - NHK and the five commercial companies - created JISO (the Japanese International Satellite Users Organization), a consortium which leased a full-time INTELSAT transponder and a US domestic transponder for their US to Japan transmission needs. For eight years, Keystone (and its predecessor, Wold Communications) provided the US domestic capacity and the West coast turn-round, including the international uplink and network control service, for JISO. This provided the Company with valuable experience of serving the growing needs of the Japanese broadcasters. By 1992, however, the situation had changed and the networks decided to end the JISO consortium, because each of the members by then had their own unilateral transPacific satellite leases.

2.3 RATIONALE

Keystone began to look at "life after JISO" and carried out research on the continuing demand and trends, and prepared forecasts for occasional video services in the Pacific Region. This research identified many factors which indicated a promising future for a new, value-added service:

- The traditional broadcasters in Japan and elsewhere in Asia were becoming accustomed to using international satellite services for news, sports and other programming.
- New commercial broadcasters were either in existence or planned - such as JSB (Wow-Wow) in Japan, SBS in Korea and Star-TV in Hong Kong.
- A new element of competition in these countries would increase the appetite for satellite delivered program material from overseas.

- The broadcasters in Asia were interested in securing end-to-end transmission services, with lower costs.

- The trend towards deregulation and privatization of national telecommunications carriers was creating an environment conducive to lower tariffs and the creation of value added services.

- There was growing interest in Asian affairs in North America and elsewhere, leading to a requirement for more news and sports coverage originating in the Region.

- And finally, the economic health of the Asian region was robust.

2.4 DEMAND

Together KDD and Keystone came to the conclusion that sufficient traffic demand existed to justify the creation of a new service, to begin when JISO ended. They therefore planned the launch of a fully-managed, one-stop shopping, video transmission service - the first of its kind in the Pacific Ocean region.

To provide continuity for the Japanese broadcasters, Keystone also worked with COMSAT to utilize the same 36MHZ zone beam transponder on INTELSAT's 180-degrees satellite as had been previously leased by JISO. And the two organizations prepared the necessary technical, operational, booking and billing procedures to make the new service work efficiently.

3.1 THE NEW SERVICE

When JISO came to an end at midnight on 31 March, 1992, K2-Skylink came into operation. The service was initially from USA to Japan only - but with one important difference from JISO: the ability to serve other customers in Japan, in addition to the six networks. It offered uplinking from Los Angeles, New York or Washington, DC, and also provided the ability to interconnect on the US East coast with transAtlantic services provided by Brightstar or Panamsat. All this with one booking, one network control center and finally one bill in one currency!

At the end of the first year of operation K2-Skylink had carried about 800 hours of transmissions - mainly news material, special events and sports coverage, but also including some services for business-tv customers. This total traffic was better than the first year forecast, comfortably above the break-even level, and interestingly better than the first year of the similar service, Brightstar, which began in the Atlantic region in 1984. So as a new business, the partners were well satisfied by the first year's result.

3.2 SERVICE EXPANSION

More importantly, they had succeeded in establishing the position of K2-Skylink in the Pacific market and during that first year, had also embarked on the expansion of the service. The first stage of expansion was to provide downlinks to other Asian countries within the zone beam coverage area. The original agreement with KDD had - for regulatory reasons - allowed downlinking to other countries only for multilateral transmissions where Japan was one of the receiving countries.

This new development therefore required the cooperation of KDD, as well as separate negotiations with each of the PTT's in other countries, to arrange for downlink facilities and for unbundled tariffs. This "independent downlinking", as it was called, began in early 1993, with arrangements in place in two of the major markets, Hong Kong and Taiwan. Later in the year, agreement was reached with Korean Telecom, and now there are plans to expand into other countries, including China, Thailand, Philippines, Malaysia and Singapore. In each case, the support and influence of the national broadcasters is an important factor in demonstrating to the telecommunications administration the level of interest in this new service, and the fact that with favorable terms and conditions, it would lead to a growth in traffic.

3.3 THE RETURN PATH

With phase two well under way planning began for phase 3: the return path, an Eastbound service from Asia to the USA. A second INTELSAT POR transponder was leased on the 180-degrees satellite, and began operations in June, 1993, with uplink services becoming available from Japan, Hong Kong, Taiwan, and Korea. In time, other countries will be added as suitable arrangements can be made for both uplinking and downlinking.

This Eastbound service was available in time to provide coverage of the Japanese Royal Wedding and for the G-7 Economic Summit in Tokyo in July, where KDD and Keystone together provided services from Japan to two of the major US networks and to CNN.

Another major example of the K2-Skylink service in the opposite direction came in November with the APEC conference in Seattle, where over 100 hours of transmission services was provided to broadcasters in Japan, Korea, Hong Kong and Taiwan. All this has contributed to a second year which so far is well ahead of the first year in the utilization of the service.

4.1 TARIFFS

Because of the need to recognize the different conditions which are applied by the administrations in each of the Asian countries, separate rate cards exist at present for each of the services.

For the original US to Japan service there is a normal occasional use tariff for end-to-end service, and lower rates for contract service. In each case, the price is expressed in two components - a US dollar component and a Japanese yen component. However, the two are combined for billing purposes - all in yen for customers in Japan and all in dollars for non-Japanese customers.

A different rate structure applies for services between the US and countries in Asia other than Japan. These figures include the entire POR space segment and all US interconnections in dollars. The Asian downlink or uplink tariff varies from place to place and is expressed in local currency. The policy of Keystone is to obtain the best unbundled tariff possible in each country, and then to pass it through to the client in one currency as part of the total end-to-end transmission cost.

4.2 CLIENT LIST

The traffic so far handled by K2-Skylink has come from an impressive list of the major clients in the first 21 months. In addition to all six Japanese networks, who have been the biggest users, transmissions have been provided for JSB and MBS-Osaka in Japan. In Taiwan, clients have included CTS and TTV; and in Hong Kong, TVB and Star-TV have been regular users. Services to Korea are now building up with KBS a major client (including lengthy transmissions on President Kim's November visit to Washington DC) and services have also been provided to MBC and SBS. In the Easterly direction, the US networks and CNN have been K2-Skylink users, also the Reuters-TV and WTN news agencies.

4.3 BOOKING SERVICE

For services from the USA to Japan, bookings are usually made with KDD in Tokyo, who then coordinate the arrangements with Keystone. This coincides with the preference of the Japanese networks - but if for some reason the customer wishes to place an order in the United States, Keystone can take the booking at the Service Booking Center in Los Angeles.

For services from the USA to other Asian countries, bookings can be made through any Keystone office. For the East-bound service, KDD or Keystone will take bookings for transmissions originating in Japan and Keystone's offices will be pleased to take orders for transmissions from any other country served by K2-Skylink.

5.1 FUTURE DEVELOPMENT

K2-Skylink, then, is an evolving and expanding service in a market which is itself evolving and expanding. However, the rate of development is conditioned to some extent by the different timetables for change and the relaxation of regulations in each country in Asia. Traditional caution and bureaucracy has to be taken into consideration - but the accelerating approach of competitive, private satellite systems has helped to loosen some of the constraints and has led (for example) to reductions in tariffs and the sanctioning of private downlinks - changes which would have been unthinkable only a year or two ago.

In this changing climate, expanded connectivity, for both East and West bound services, is very much a part of the future plans for K2-Skylink. It is not intend that the service should be limited to the boundaries of the existing zone beam capacity but that it will be expanded to serve the Southern pacific and other markets when suitable space segment becomes available - either from INTELSAT or from one of the private satellite systems.

Digital compression is also under careful review and we some test transmissions may take place later this year. When the market is ready, it is proposed to introduce new digital services which will meet two needs - first, a lower cost alternative; and second, the ability to effectively increase capacity in order to meet growing demand or to handle booking conflicts.

SNG is another area under study, encouraged by some Asian clients who are interested in some form of shared or occasional C-band SNG capability in the region; or a future development into Ku-band capacity, perhaps with the steerable spot beam capability which is planned by INTELSAT and Panamsat. Shared capacity requires someone to provide the service management, and Keystone Communications sees this role as a natural development of K2-Skylink.

5.2 CONCLUSION

This has been an overview of K2-Skylink, how it began, what it now offers and where it is going. KDD and Keystone will welcome the comments and questions of delegates, which will help to ensure that the service meets the current needs of the broadcasting and other video markets, on both sides of the Pacific Ocean.

Mixed Media - Open Networks : New Paradigms for Distance Learning

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1. ABSTRACT

The purpose of the paper is to develop the relationship between the advancement of modern telecommunications systems and services and the availability and exploitation of various educational media, and their contribution to the evolution of a fundamentally new paradigm for distance learning. By reviewing general developments and citing specific technology applications, the author will argue that current networking capabilities and the convergence of technologies provide educators with unprecedented opportunities for optimizing their use of electronic media.

2. The Learning Imperative

The need to enhance overall levels of education has become a central premise of national strategies aimed at social, cultural and economic development. In advanced economies, the need to sustain overall competitiveness has placed increasing demands on both the formal educational process as well as on systems for industrial training. In the developing world, there is a like requirement to equip large numbers of citizens with the basic skills necessary for economic and social advancement. For this reason, educational policy has risen to the top of the public policy agenda in virtually all countries around the world. [1]

Along with the realization of the importance of education has come a demand for expansion of the capacities of learning systems which many countries have found difficult to satisfy. This problem has even posed significant problems for relatively wealthy states, but it has attained almost "crisis" proportions in developing countries with much fewer resources at their disposal. It has become evident that the deployment of communications and information technologies can play a vitally important role in responding to this situation. This reflects the rather obvious fact that these technologies have magnified the possibilities for improving the quality and cost of education, both inside and outside of the conventional classroom setting, through "open learning" and distance education.

Although educational policy makers have generally recognized the need for new techniques and arrangements for learning, and acknowledged the role which modern communications and information technologies can play in their formation, there has been little clear exposition of the exact manner in which this could come about. One of the first steps in this process is a clarification of the relationship between the advancement of modern telecommunications systems and services and the availability and exploitation of various educational media. By reviewing general developments in technology and citing specific applications, the author will argue that current and evolving networking capabilities and the convergence of technologies have produced unprecedented opportunities for optimizing their use in education and training. The resulting capacity to fashion innovative combinations of instructional media and to optimize the deployment in distance education can mean the evolution of a fundamentally new paradigm for distance learning.

3. The Optimization of Educational Media

A number of media, utilizing a considerable range of technologies, have been applied to the cause of distance education and training.[2] Print and text have been the dominant medium for a number of years, and still remain the most common medium employed internationally. While print or text-based material continues to be widely used throughout the educational community, various electronic technologies are playing an increasingly important role in their design and preparation. Moreover, print/text is increasingly used in combination with electronic forms of information technology for the conduct and delivery of distance education courses.

In the field of electronic communications and information technologies, virtually all forms of electronic media have been employed for education, from simple audio-cassettes to the more sophisticated forms of multimedia computer-based training (CBT). These consist of one-way as well as telecommunications based, interactive technologies; and include technologies which are both strictly audio in nature and those that involve a visual or image component. By and large, electronic media have been used most effectively in concert with, and often as a complement to, print-based materials.

Each of these various media have proved to have strengths and weaknesses, which often vary depending on the learning situation involved. Questions of the appropriate medium for a particular learning experience are often dependent on the nature of the subject matter, mathematics versus civics courses for example; the level of instruction, i.e. graduate engineering versus high school science; the nature and numbers of students participating; as well as the general cultural and institutional environment in which instruction is taking place. Certain combinations of these factors may dictate the need for inter-activity in some form, which has been the experience at Commonwealth of Learning (COL) where much of our technology work has been directed at exploiting the value of inter-active audio-teleconferencing for tutorial support and instructional applications[3]. We have also encountered learning situations which place special importance on an image component to the media package. In other circumstances, however, instruction may be adequately and more efficiently handled by use of simpler, audio-based, one-way technologies. The MASSLIP program in Ghana, for instance, has made effective use of audio-cassettes in its efforts to upgrade basic education and literacy.

Based on this experience, there is thus less and less support for the notion that a particular medium or technology represents the ideal platform for open learning. In fact, in a given institution or within a particular program or course, or even during a given instructional event, there may be a requirement for a combination of media. In a well equipped classroom situation, this need to mix and match media can be easily accomodated. In a distance education context, however, there has been much less flexibility from an instructional standpoint, since the communications networks and technologies employed for distance education typically developed quite separately from one another, and were usually dedicated to a specific medium or user need. As a result, educators had limited ability to customize media to a particular requirement or situation.

Recent trends in technology have the potential to overcome these traditional drawbacks : first, through the increasing power and functionality of digital telecommunications networks, and secondly through the rapid convergence of media, also driven by digitalization.

4. Open Networks

The increased power, scope and flexibility of modern communications networks is probably the most measurable element in the so-called "information revolution". This has come about primarily through the introduction of new transmission technologies, such as satellites and fibre optics, which have created larger and larger "pipelines" for information flows. As these telecommunications networks become increasingly based on digital technologies, they also permit the packaging of huge volumes of information in a more compact and functional form and thus become more flexible from an applications standpoint. Communications networks have therefore become multi-purpose communications pathways capable of meeting a diverse range of communications needs.[4]

The multi-functional capacity and flexibility required for distance education networks has been demonstrated in recent work done by COL in designing a network plan for the Asia-Pacific region.[5] Based on extensive consultations with the educational community in the region, conducted by COL and its consultant, the study determined that the institutions' immediate needs centred on reliable, inter-active communications and on flexibility in terms of the type and scope of network services available. . The specific requirements for the network consisted of high quality telephone conferencing, computer messaging (e-mail), file transfer and facsimile. Such a package of services was considered to supply a basic level of distance education capability in terms of the delivery of courses and materials to students. Audio-teleconferencing, as a vehicle for instruction and tutorial support, was considered a particularly vital element in the group of services necessary for programme delivery. The network design therefore needed to accomodate a selection of distance education related communications services and to offer several layers of network capability.[6]

The multi-functional nature of the proposed COL network is demonstrative of the manner in which modern telecommunications networks can expand the range of media combinations available to institutions. This capability can be expected to grow as new forms of networking emerge, what some have termed "multimedia communications", which combine and surpass the capabilities of traditional networks. Telecommunications services based on the concept of an Integrated Services Digital Network, or ISDN, are often considered to be the most evident illustration of this phenomenon, at least on a widespread public network basis. By digitalizing the communications stream, ISDN-based networks provide a more versatile and functional package of advanced "multimedia" services which can overcome the complexity and cost of the multiple terminals, access arrangements, and networks that characterize current service offerings.

The provision of ISDN-based services already has begun to allow educators to more easily combine various media, i.e. voice, data, and image, within a single distance education link. "Narrowband" ISDN provides a primitive multimedia communications channel by permitting users to exchange a page of text, a graphic or an image ('still motion video') at the same time they conduct a telephone conversation. The strength of these technologies for educational applications has been previewed in COL's work with "narrow-band" videoconferencing. As one of the least innovative uses of inter-active video technology is an electronic replica of a teacher to classroom situation (which is often a "talking head" exercise), our applications work has focused on various specialized uses to which the unique properties of narrowband videoconferencing can be applied. The best examples of this concerned a series of events organized with the Faculty of Music, of the University of British Columbia. The conferences linked experts from U.B.C. and the Vancouver area with their counterparts in several Australian universities for the purpose of comparative study of music among First Nations Peoples, the Chinese communities in both countries, and young children. On another occasions, in an exercise in continuing judicial education, officials from the Supreme Courts of British Columbia (including the Chief Justice) and Australia have met electronically to exchange information on subjects related to the application of the criminal law. [7]

Even more powerful applications can be contemplated as telecommunications operators begin to offer service arrangements that essentially provide "Bandwidth on Demand" to users. The making available of digital broadband services in this manner greatly multiplies the quantity of messages that can be simultaneously exchanged, incorporating close to full motion video or high speed data applications, and consequently provides a more versatile and functional package of advanced "multimedia" services. Some telecommunications carriers, such as Southwestern Bell in the U.S., have begun to develop tariffed services along these lines.[8] As these become more widely available, distance education institutions will experience greater flexibility in tailoring their telecommunications requirements to specific needs, even when called for on an occasional use basis.

5. Convergence of Media and Technologies

In addition to expanding the capacity and range of networks, the pervasiveness of digitalization in modern information technology has brought about the reduction of communications and message types to a single common denominator, the computer byte, and thus has produced a phenomenon called convergence. The consequent blending of communications and information technologies through digital technology permits the combining of message types- voice/audio, text and image/video, and their corresponding media into forms which replicate more and more closely the dynamics of face to face communications. Moreover, as the boundaries between traditional media evaporate, technology will permit the integration of communications media such as telecommunications and broadcasting with "stand alone" educational technologies, particularly those which are computer based.[9]

In an educational context, convergence means an unparalleled opportunity exists to mix and match media to a particular educational need. Ultimately, the "electronic classroom" of the future will enable educators to weave media together much more easily than in the past, in a manner which will generate more 'natural' media interfaces and more satisfactory results for an instructional perspective.[10] The personal computer, because of its growing capacity to operate as a standalone text and numerical processor, communications terminal (for e-mail, file transfer and facsimile) and video display unit (through video boards and CD-ROM peripherals) "all-in-one", plays a central role in this process.[11] This will have a profound effect on the design and equipping of "learning centres" for distance education, which in their various forms are becoming more and more prominent as a vehicle for the delivery of education and training. Models for the innovative mixture of communications and computer technologies which convergence makes possible can be seen in the many "tele-commuting" and "tele-cottaging" systems now in operation.[12] Although not primarily educational exercises, the "tele-commuting" and "tele-cottaging" experiences are illustrative of the manner in which the concentration of information technologies in communications centres or "hubs" provides a "media-mix" which can support remote activities of various kinds.

6. Conclusion : Open Networks and Mixed Media

The "open network" models which are now emerging in the realm of telecommunications can provide a practical and effective means of supporting a "mixed media" approach to the use of technology in education. In contrast to the previous models of distance education, therefore, which were often unidimensional in terms of the technologies and media they employed for instruction, the combination of "open networks" and "mixed media" provides the educational community with a much more effective platform for responding to the learning imperative inherent in development. While these developments taken together are the basis for a radically new paradigm for distance learning around the world, there are many challenges to be overcome by the educational and communications communities alike.[13] COL looks forward to assisting members of both communities in responding to these challenges.

ENDNOTES

1. For Canada's response to this challenge, see the Prosperity Secretariat's discussion paper, Learning Well - Living Well, Ottawa, 1991, and the Steering Group on Prosperity report, Inventing our Future : An Action Plan for Canada's Prosperity. Ottawa, 1992.

2. See A.W. Bates, "Educational Technology in Distance Education," Vancouver : Open Learning Agency 1992.

3. These and other applications are cited in Overview of Telecommunications and Technology Activities. Vancouver, B.C. : The Commonwealth of Learning 1993.

4. See Office of Technology Assessment, Critical Connections : Communication for the Future. Washington, D.C., 1989.

5. R. Matyas, Study of Educational Telecommunications Requirements for the South Pacific. The Commonwealth of Learning: Vancouver, B.C. 1993. For related work, see also C. Matthewson, "Commonwealth Asia Pacific Distance Education Networks (CAPDEN)". The Commonwealth of Learning: Vancouver, B.C. (Mimeo) 1993; and Peter McMechan and C. Matthewson, "A Commonwealth Asia-Pacific Distance Education Network" in Distance Education Futures, ed. T. Nunan. University of South Australia 1993.

6. See R. Simpson, "Telecommunications Networks in Distance Education - A Model for Small States". Paper presented to the Annual Conference of the International Institute of Communications. Mexico City, September , 1993.

7. See Overview of Telecommunications and Technology Activities.

8. Newsbytes News Network, September 8, 1993

9. Gareth Sansom, "New Media Technologies : A Background Document for New Media...New Choices." Ottawa : Department of Communications, 1992; and Paul W. Holmes, "Report on End-User Applications of Distributed Multimedia : Image Processing Technology." Ottawa, 1991.

10. Roger Hough, Classrooms of the Future : An Inquiry into the Evolution of New Media in Canada. Ottawa, 1992; and, SIMBA Information Inc., Electronic Media for the School Market. September, 1992.

11. Communications Sciences Research Corporation, A Study of the Application of CD-ROM and Networking Technologies to Developing Countries, Commonwealth of Learning: Vancouver, B.C., April, 1993; and National Council for Educational Technology, CDROM as a Means of Distributing Scholarly Publishing to Developing Countries. (A Report to the Commonwealth Secretariat). London, 1992.

12. For examples of "telecommuting", see Computerworld, December 16, 1991; and Thomas G. Miller, "Telecommuting : The Coming 'Second Wave', LINK Resources, October, 1989.

13. See John A. Gilbert, Telecommunications In Support of Education : An Agenda for Telecommunications Companies and Educators. Vancouver, B.C. : The Commonwealth of Learning 1993.

CREAD: An Ongoing Example of an Inter-American Effort in Collaboration in Distance Education

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This paper describes a new collaborative effort, the *Consorcio Red Educación a Distancia* (CREAD). CREAD's mission is to foster the development of inter-American distance education, using multiple technologies, through a process of interinstitutional cooperation.

Educational telecommunications are envisioned as a means to increase access to education in developing countries. The expanding interest in educational telecommunications in developing economies, evidenced by the infrastructure commitment in universities and ministries of education, demonstrates growing awareness of educational telecommunication's perceived link to educational progress. However, often these preliminary efforts to improve educational access through the use of distance education remain limited in scope and restricted to a particular locality. Technology, which could be used as a means to move beyond perennial parochialism and expand access to education, often does not reach its full potential. Collaborative efforts are needed to overcome the barriers of the developmental costs of integrated visual, voice and data communication systems, curriculum design for distance delivery, and education and training needs in the use of the new technology.

Relations among Latin America, the United States and Canada are also changing rapidly. A number of forces affecting cultural, social, economic and political activity are driving these changes including the information exchange made possible by new technologies, global and regional economic and environmental changes, increasing demands on higher education as well as the recently passed North American Free Trade Agreement (NAFTA). In addition, pressures from stakeholders in higher education for collaborative efforts to contribute to each country's cultural and social development and global competitive capacity led to a greater need for inter-American cooperation.

This paper describes a new collaborative effort, the *Consorcio Red Educación a Distancia* (CREAD), a consortium which focuses its attention on helping break down barriers to educational parochialism in Latin America, the United States and Canada through an inter-American collaboration. The paper explains the purpose of CREAD, its history, its vision, its membership and activities, and suggests its future impact on the socio-political context of developing countries in Latin American and its potential for enhancing international cooperation.

CREAD An Inter-American Consortium for Distance Education

In October 1993, after a series of preparatory meetings in Canada, Latin America and the United States, representatives from higher education, business, foundations and governments met at Pennsylvania State University to charter the *Consorcio Red Educación a Distancia* (CREAD). An organization driven by its member institutions, "CREAD" is an acronym from the Network's title in Spanish, French and Portuguese. In English, CREAD means the Consortium for Distance Education Network. CREAD's members, publications, and programs embrace all four languages. Bylaws were developed for the newly independent organization and a board of directors representing nine regions were elected. Pennsylvania State University offered to become the institutional host for CREAD activities.

The mission of the new organization is to foster the development of inter-American distance education through a process of interinstitutional cooperation. The vision includes the commitment to creating strong partnerships which will enhance greater access to the vast potential and effective development of each country, the commitment to providing quality education to improve the standard of living of citizens and the overall quality of life, the commitment to a better understanding of distinctive cultures and identities and enhanced cooperation between respective countries.

Membership in CREAD includes Inter-American institutions and individuals interested in cooperating in an effort to increase educational opportunities in the Western Hemisphere through distance education. Currently, 350 member institutions participate as well as many individual members.

The partnerships created by CREAD help countries fulfill their education and research objectives and at the same time respond to innovation and the application of new technologies to educational development. CREAD has three principal objectives:

1. to provide access to a broad inter-American institutional network of distance education programs and activities
2. to enhance skills of faculty and administrators to effectively use new technologies for education through training seminars, workshops and conferences
3. to assist higher education institutions in the marketing of materials and services

The development of CREAD required the development of strategic alliances among higher education institutions over a period of three years. A brief review of the history of the development of CREAD reveals the commitment and need for this educational network.

In 1990, the widely recognized need within Latin America to exchange information about distance education led Venezuelan educators to develop a proposal to host the World Conference of the International Council for Distance Education (ICDE). The Venezuelan proposal was endorsed by the Organization of American States and major educational institutions in Latin America. At the same time, the Inter-American Organization of Higher Education (IOHE), headquartered in Canada, was also discussing the need for greater exchange. Dr. Armando Villarroel from Venezuela, was invited by IOHE to work on a strategic plan to enhance collaboration between countries. Both OAS and IOHE were represented at the World Conference.

CREAD, as a project, was born during discussions at the XV World Conference of the International Council for Distance Education in Caracas, Venezuela, in 1990. A group of educators attending the Conference met and joined with the three agencies to develop a collaborative approach to furthering awareness of and knowledge about educational telecommunications' role in addressing problems of educational access throughout the Americas. The three agencies included IOHE, OAS, and the Canadian International Development Agency.

Two premises inspired CREAD from its inception: (1) a belief that technology can be used to make education humanized and personalized as well as more universal; and (2) education should address local needs while introducing and adopting a more global perspective.

The CREAD Project began its work in 1991 with Dr. Villarroel as the Project Director. The first phase involved a feasibility study which determined that there were uses of distance education already in practice in many countries. Surveys were conducted using questionnaires developed in Portuguese, Spanish, French and English and distributed through a network of interested institutions. The study involved interactions with these institutions for a period of one year.

Information was gathered on programs offered at the associate, undergraduate and graduate level. In addition, information was collected on the areas of expertise that institutions could offer to share and those areas where institutions perceived a need for assistance.

In November 1991, heads of educational institutions from across the Americas held a meeting in Santo Domingo in the Dominican Republic to hear Dr. Villarroel's report on the feasibility study. As a result, a plan of action was developed for CREAD and an Advisory Board was created. The Board decided to work in four areas: access and links to knowledge and information through technology; human resource training and materials use in distance education and development of a process model; institutional coordination; and organization of this endeavor through special projects. In terms of human resource development, CREAD designed a training program comprised of eleven modules, of which three (3) have been completed, delivered in an intensive workshop format. The plan involves developing one new module each year and repeating it each year.

The three modules developed to date include (1) Introduction to Distance Education, (2) Course Design, and (3) Use of New Technologies. The workshop for the first module was hosted by Laurentian University in Canada and the Universidad Estatal a Distancia de Costa Rica. It was held in late October 1992 at a total of three sites. These sites were Nicaragua, Mexico, and Costa Rica. Twenty-five people participated in each site. In Mexico and Nicaragua, participants were local or from the host country. In Costa Rica, participants were international, coming from Argentina, Brazil, Columbia, Venezuela and other Latin American countries. The materials used in this workshop were lent by the Commonwealth of Learning in Canada and translated into Spanish by CREAD for the workshops. Instructors in the workshop included Ross Paul, President of

Laurentian University in Canada, Roger Mills from the Open University of Great Britain, and Hilary Perraton and Jane Brindly from Canada..

The second workshop was on "Course Design" and also offered in October 1992. The host institutions were the Annenberg CPB/Project of the U.S.A. with Peter Dirr, then Deputy Director of Annenberg a key organizer, University of Maryland, Universidad Nacional Abierta of Venezuela, and the Open Learning Agency of Canada. It was held at the Universidad Nacional Autonoma de Mexico (UNAM), the largest educational institution in Mexico. The instructors in this workshop were Gary E. Miller, U.S.A., Valerie Crane, U.S.A., Frederick Barsik, U.S.A., Lucio Teles, Simon Fraser University in Canada, and Fabio Chacon from the Universidad Nacional Abierta, Venezuela.

The third workshop, "Use of New Technologies in Education," was offered in November-December 1993 in Monterrey, Mexico. The host institution was the Technological Institute of Monterrey. Instructors included faculty Daniel Prieto Castillo and Amable Rosario from Radio Nederland, Patricia Nelson from Susquehanna University, U.S.A., Patricia Book, from Penn State University, U.S.A., Lucio Teles from The Open Learning University, Canada, Rosa Elva Elizondo, from VENTURUS, Monterrey, Ciro Velazquez and Hugo Garcia Torres, ITESM, Monterrey.

Impact on Socio-Political Context

One of the aims of CREAD is to use technology to help provide equal access to education to its participating partners. Political structures and economic structures all over the world have become intermingled, each one rapidly affecting others. Through telecommunications technologies we have become aware of other nations' events and can set up collaborative efforts in minutes. It is hoped that this continued spread in the use of telecommunications should have a positive effect on education and training as well.

Telecommunications technology has the potential effect of facilitating educational access to previously disenfranchised and under served populations.

There has been an initial tendency for the already economically powerful and better educated groups to take advantage of the educational possibilities presented by the new technologies. In developing societies, such as those in Latin America, the gap between the privileged and the underprivileged is already great. Studies indicate that the initial effect of introducing technology into an educational system has been to broaden the gap between the rich and the poor. Attempts to counteract this problem have been seen in the creation of such programs as the Star School Program and the Rural Satellite Program in the United States. The fact remains however, that if left unchecked, technology may not only fail to become the great equalizer but may become an obstacle to equality. Furthermore, local cultural values and traditions may be ignored if regional participants are not involved in educational decision making or if the users have no idea that such a possibility exists. Another concern raised by the use of technology is the ownership of knowledge. Whose knowledge will infiltrate into education circles and whose knowledge will be rendered invisible?

The creation of meaningful multi-lingual and multicultural partnerships will help close this gap and promote the establishment of telecommunications as a vehicle to promote equal access to education. Partner nations in CREAD will benefit from shared responsibility and expertise. Mexico, for example, plays an impressive role in the adoption of technology for education purposes through the Instituto Tecnologico de Estudios Superiores de Monterrey (ITESM). ITESM is one of CREAD's charter members. Their efforts with the Mexican Secretariat of Public Education in the training of large numbers of school teachers has earned them recognition in the United States. The potential benefits of transnational collaborative efforts such as CREAD for enhancing international cooperation are great.

Potential for Enhancing International Cooperation

In the short span of only two years we have witnessed significant events pointing toward a "changed world order." The United Soviet Socialist Republic has disintegrated, the European economic community solidified, Israel and the Palestine Liberation Organization have signed a peace accord, and the North American Free Trade agreement (NAFTA) has become a reality.

World leaders recognize the inevitability of international collaboration and conflict resolution. New responses to increased need for international collaboration can be found in research and development efforts, joint business ventures and educational partnerships. Technology has enhanced the exchange of information, facilitated the conduct of business, and increased access to education and training. Technological advancements in general and telecommunications in particular will continue to erode the geographic boundaries of nations and organizations. We have witnessed the global interdependency of economies. Indeed, through advances in communication technology we can establish collaborative efforts quickly. President Clinton of the United States has stated in his support of NAFTA that today's economic development schemes must be conceived in the context of blocks of nations.

The effect of the globalization of economies and the internationalizing of curriculum impacts our everyday work as educators. The favorable predisposition toward a global focus, international cooperation and sharing facilities provided by communication technologies makes the undertaking of joint efforts such as CREAD both a distinct and desirable possibility for institutions of higher education.

In the same way that information can be quickly spread through telecommunications, knowledge about the use of various education telecommunications systems is being quickly disseminated. There is a growing awareness of the need for audioconferencing and for the use of electronic mail which is expanding over the Americas. Audioconferencing for educational instruction, which is one of the least expensive and most flexible of these technologies has rapidly been considered, employed and adopted in Latin America. In the United States and Canada, many modes of educational telecommunications have been in use for instruction. In Latin America advanced satellite communication for educational purposes is also being implemented through Worldnet (USA), Morelos II (Mexico) and Hispasal (Spain).

The use of technology can enhance mutuality in international cooperation by facilitating collaborative decision making and shared learning experiences. However, these collaborative experiences may redefine our internalized perceptions of traditional education in developing countries. The traditional position is basically that of the educational provider. Those who need education are perceived as potential knowledge recipients and other educators as potential market competitors. Knowledge is seen as a commodity to be bought and sold. Accreditation, as determined by external criteria, becomes a quality seal that the right product has been bought. This is what Paulo Freire has called a banker's approach to education. Technology becomes in this conception an ideal manner to efficiently disseminate the expert's message.

CREAD represents another conception of education. Its position stresses collaboration, both in the process of designing and delivering educational products. A team of education experts replace the individual expert and their roles become that of co-facilitators. Other educators are perceived as potential partners not competitors and the challenge becomes how to put in place a process by which cooperation is fostered in the achievement of pertinent and high quality educational products. Even though accreditation remains an important issue, the main thrust is to determine how to better meet the client's needs. Technology becomes the main vehicle to identify and administer partnerships. The emphasis of this approach is therefore on the process rather than on the product.

Finally, the use of communication technology to build mutual partnerships implies: a) recognition of the desirability of working in teams; b) that there is value in knowledge acquired by other experts, institutions and cultures; c) that educators, as perpetual students, can greatly benefit by multi-cultural and multi-lingual colleagues when working in joint ventures; and d) that one's own personal and institutional interest can very well be served when working in the context of international collaborative efforts.

Extension Programs of Taiwan Academic Network (TANet)

--- Policy, Strategies, Enforcement and Training Programs ---

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1.Abstract

TANet (Taiwan Academic Network) has been introduced to academic fields in Taiwan area for a few years. To disseminate educational resources and cut down the difference of educational level between urban and suburban areas, the Ministry of Education (MOE) decided to extend TAnet to serve overall schools in taiwan. The study included two major parts: the first part evaluated and analyzed extension environment of TANet; and the second proposed and selected alternatives and strategies.

2. Introduction

Most developing countries have such common problems as scarcity of foreign currency, low credit ratings, comparative neglect of the more remote areas and lack of trained personnel. Fortunately, Taiwan, the Republic of China, as one of the developing countries, has only the problem of relative neglect of the more remote areas in the country. TANet (the Taiwan Academic Network), which internationally interconnects with Internet, JvNCnet, and NFSnet, has successfully been installed and applied in the major western corridor of Taiwan as telecommunication backbone for academia. Higher education units, including universities, colleges and technology institutes, appreciate the expansion of telecommunication networks to the world. However, there is a disparity in the extent and quality of service between urban and remote areas. The Ministry of Education (MOE) therefore consider the most cost-effective way to stimulate and support the range of activities that might be needed to achieve a more balanced expansion of telecommunications networks for education.

The MOE therefore decided to extend TANet service to senior high schools, professional high schools, junior high schools, and even elementary schools.The MOE entrusted 'TANet Extension Group' at National Central University to perform feasibility study in the time period of Nov. 1992 to Jun. 1993. The study included two major phases: the first phase evaluated and analyzed extension environment of TANet ; and the second proposed and selected alternatives and strategies .

In the beginning, we proceeded with exploratory and descriptive investigation on literatures, previous experiences and questionnaires surveys. Possible impedance in extending TANet is identified and provided with alternative solutions . The results thus far can be divided into the following three major parts: (1) analysis of existing status of TANet and demand of information education for every educational units, (2) statistical and contingency analysis of questionnaires and the six symposiums held islandwide, and (3) deliberation on TANet extension alternatives and their evaluation.
Consequently, the global framework for extending TANet service was prepared. The implementation strategies were separated into short-, mid-, and long-term stages.Criteria for choosing experimental educational units are prepared as well. As a closure, the required funding, softwares, hardwares, personnel and educational training programs to accomplish the TANet extension were also suggested.

3. Framework of the Study

As illustrated by Figure 1, two phases could be identified for the framework of the study: the first phase includes the analysis and evaluation of the environment of extended TANet; and the second phase concludes with the proposed alternatives and implementation strategies.In the first phase,we proceeds with exploratory and descriptive investigation on literature, previous experiences, and questionnaires surveys. The first phase could be stated as follows.

1. The findings from the collected literature are classified according to network framework and supplementary measures.
2. Hold six symposiums with the delegates from 40 private companies, 350 educational units, and 16 government agencies. Their results are documented, synthesized, and cross-compared among counties, region, educational level and various investment.
3. Follow-up questionairs are issued to 350 educational units. The rate of response is about 90 percent. Fruitful opinions, suggestions and miscellaneous potential problems are brought out.
4. As the closure of the first phase, exploratory analysis and descriptive investigation are enforced to integrate questionaires results and previous experiences.

According to the result of the first phase, the findings are futhermore eelaborated by network structure and supplementary measure . Criteria for choosing alternatives could be dervided by elaborating on such supplementary measures as personnel, funding, training programs and equipment. A complete extended TANet structure is proposed as the result of brainstorming on network structure by technology, geographical location and educational organization. Guidelines are then setup for implementing the extend TANet. finally, we surface short-, mid-, long-term strategies for implementation, the guidelines for leased circuits, training programs and choice of experimental education units.

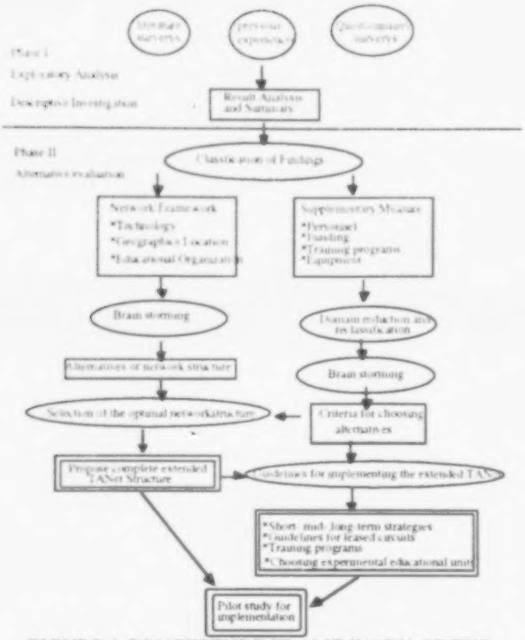

literature surveys
personal experience
Questionnaire surveys
Phase I
Exploratory Analysis
Descriptive Investigation
Result Analysis and Summary
Phase II
Alternative evaluation
Classification of Findings
Network Framework
*Technology
*Geographics Location
*Educational Organization
Supplementary Measure
*Personnel
*Funding
*Training programs
*Equipment
Brain storming
Domain reduction and reclassification
Alternatives of network structure
Brain storming
Selection of the optimal networkstructure
Criteria for choosing alternatives
Propose complete extended TANet Structure
Guidelines for implementing the extended TANet
*Short- mid- long-term strategies
*Guidelines for leased circuits
*Training programs
*Choosing experimental educational units
Pilot study for implementation

FIGURE 1 CONCEPTURE FRAME WORK OF THE STUDY

4. Status of TANet (Taiwan Academic Network)

The Taiwan Academic Network (TANet) is a commonly-used national academic network managed by Ministry of Education (MOE) of Taiwan and the choosed University Computer Centers .It provides telecommunication ability and resource shared environment for research and academic fields in Taiwan. Certainly, it also provides better environment for computer education.TANet is therefore the major part of Taiwan Internet community which may interconnect with other industrial or commerical network such as SEEDnet.

There exist a two-layer management hierarchy of TANet.They are TANet Service Center (TANSC) and Regional Network Service Centers (RNSC).TANSC is responsible for construction national backbone network and international links. RNSCs play the role of supporting to connections and providing the necessary services to internal local area networks with interface associated with TANet backbone in a regional respectively. TANSC is administered by the MOE Computer Center, and RNSCs are administrated by leading regional universities. Taiwan is divided into serven TANet regions. They are Taipei area, Taoyuan area, Hsinchu area, Taichung area, Yun-Chia area, Tainan area and Kaohsiung area.Each area has a RNSC. They are National Taiwan University in Taipei area, National Central University in Taoyuan area, National Chiao-Tung University (NCTU) in Hsinchu area, National Chung-Hsing University (NCHU) in Taichung area, National Chung-Cheng Uiversity (CCU) in Yun-Chia area, National Cheng-Kung University (NCKU) in Tainan area, and National Sun-Yat Sen University in Kaohsiung area.

High speed T1 circuits (1.544 Mbps) are installed between TANSC, RNSCs and some other universities. The topology of TANet is shown in Figure 2. TANet primarily focus on TCP/IP protocols. Local area networks may support multi-protocols and facilities, such as X.25 transport or dial-up services on a local basis. Current Taiwan BITNET applications are supported by TANet via IP connections.The TANet backbone uses a ring topology. It interconnects high speed leased circuits and local area network by routers. Global telecommunication need will expedite moving toward higher bandwidths on the backbone links. Each local link bandwidth depends on its local requirements.The international link bandwidth is 256 Kbps between MOE and Princeton University (JvNCnet). This link also relates with JvNCnet, NFSnet and international Internet.

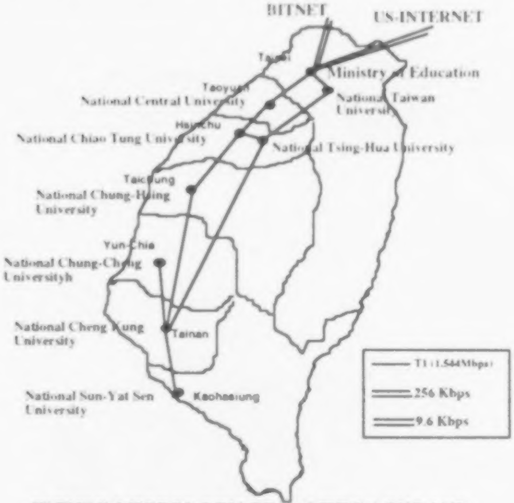
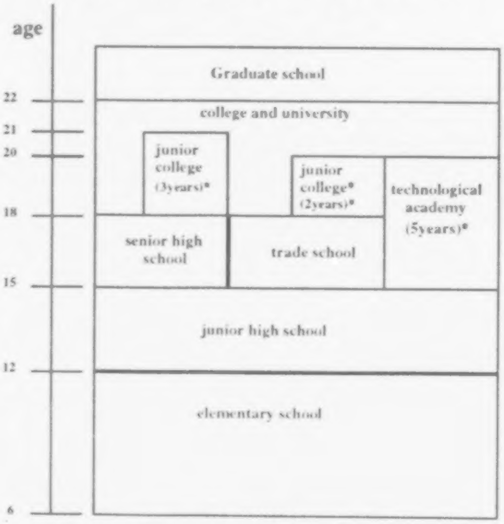

BITNET
US-INTERNET
Taipei
Ministry of Education
National Taiwan University
Taoyuan
National Central University
Hsinchu
National Chiao Tung University
National Tsing-Hua University
Taichung
National Chung-Hsing University
Yun-Chia
National Chung-Cheng Universityh
National Cheng Kung University
Tainan
National Sun-Yat Sen University
Kaohsiung
T1 (1.544Mbps)
256 Kbps
9.6 Kbps

FIGURE 2 TOPOLOGY OF TANET BACKBOND

5. Computer Education Program in Taiwan

In general, educational units in Taiwan could be classified into six categories, including university, college, technological academy, vocational high school, senior high school, junior high school, and elementary school. The hierachy of educational system is exhibited as Figure 3.


age
22
21
20
18
15
12
6
Graduate school
college and university
junior college (3years)*
junior college* (2years)*
technological academy (5years)*
senior high school
trade school
junior high school
elementary school

*technological academy(5 years) and junior college(3 years,2 years) graduate could go to graduate school or university

FIGURE 3 TAIWAN SCHOOL EDUCATION SYSTEM

In relation to the extended TANet program, computer education for education system except university and college is investigated and summarized by objective of computer education, course, equipment and source of instructors, as follows:

5.1 Junior Colleges and Technological Academics

Obectives
-To provide students with fundamental computer concept and skill of computer programming.
-Application of commecialized softwares in related areas.
-Ability of elementary system analysis and design.

Courses
-4 credit hours lecture and 4 - 8 hours laboratory in the least.

Equipment
-Each education units possesses at least a mini computer and a teaching-oriented computer room. A computer center is also mandatory for managing computer resource and computer education.

Source of Instructors
-Same as universities and college.

5.2 Vocational high schools

Obectives
-To provide students with fundamental computer concept and basic skill of one kind of computer language programming.
-Basic application of commecialized softwares in related areas.

Courses
-2 credit hours lecture and 4 - 8 hours laboratory in the least.

Equipment
-Each education units possesses at least a teaching-oriented computer room, and the number of personal computers should be more than 40 sets.

Source of instructors
long-term
-Instructors would be trained at the Department of Information, National Taiwan Normal University and other universities.
mid-term
-More than 700 teachers of trade school have been selected for a 20 credit-hour lecture from 1984 to 1990.
-About 360 teachers per year have received 20 credit-hour lectures for computer education since 1991.
short-term
-Tutorial courses and seminars for improving teachers' ability of manipulating computer.

5.3 Senior high schools

Obectives
-To provide students with fundamental computer concept.
-To provide students with principle of computer for further study.
-To provide students with basic skill of computer programming and using computer to process data.

Courses
-2 credit hours lecture and 4 - 8 hours laboratory in the least.

Equipment
-Each educational unit possesses at least a teaching-oriented computer room, and the number of computers should be more than 30 sets.

Source of instructors
-Same as vocational high school.

5.4 Junior high schools

Obectives
-To provide students with concept of applying computers to their own daily life.
-To provide students with knowledge of computer history, development, current status, and it's impacts.
-To provide students with fundamental principle of computers.

Courses
-There is no particularly regular course for computer education. But in the course of "arts and crafts", the teacher should would give a 12-hours study of computer in the second grade (8th grade in U.S.) and 10-hours study for the third grade.

Equipment
-Each educational unit possesses at least a teaching-oriented computer room, and the number of computers should be more than 10 sets. In practice, formal computer room is not available for some schools.

Source of instructors
long-term
-Computer training is prerequisite for a student at normal universities. So that each graduated teacher would have computer concept and ability to teach computer courses.
mid-term
-Some of teachers have been selected for a 20-credit lecture of computer education.
-Some regional training courses are available.
short term
-Tutorial courses and seminars for improving teachers' ability of computer.

5.5 Elementary schools

Objectives and Courses
-There are no computer course yet in elementary schools.

Equipment
-In Taipei and Kaohsiung Cities, the governments have allocated budget for purchasing computer equipment for elementary schools. Some schools have a teaching-oriented computer room.

Source of instructors
-Same as junior high school.

6. Major Findings:

The major findings are summarized according to the results obtained from the six symposiums held islandwide and the results from the follow-up questionnaire survey.

6.1 Major Finding From The Six Symposiums

These findings are synthesized and classified into the following seven categories:

1. Execution
Much effort should be put into coordination among the Ministry of Education,local government and education institutes. A significant portion of educational units hesitates taking part in the extended TANet program simply

because technical problems they might get involved.

2. Funding

Lots of concerns are on (1) charging rate to various levels of educational units that share the extended TANet resources, (2) the structure of authorized agency to deal with charge rate, (3) most junior high and elementary schools short of expenditure on computer resources, and (4) subsidy of the expenditure of leased circuits to regional centers of the extended TANet.

3.Softwares

Focuses are on (1) the channel to broadcast CAI (Computer -Aided Instruction) softwares and their guidelines, (2) the authorization of copyright, (3) a user-friendly user interface, (4) the participation of private telecommunication and software companies in the CAI market, (5) the priority disciplines for applied areas.

4.Hardware

Emphasis is put on (1) the feasibility of making standards for hardwares, (2) the possibility of building regional maintenance centers, and (3) the amount of modem dial-up for regional centers.

5.Training programs

Results include (1) computer education of the extend TANet for teachers, (2) the feasibility of instituting district training centers, (3) the possibility of training teachers with fundamental technical and networking courses, (4) the inclusion of the extended TANet courses into normal colleges, and (5) the involvement of private companies in the training programs.

6.Personnel

Important issues for personnel comprise of (1) promotion of the degree of participation for administration of educational units, (2) the problem of insufficiency of technicians, and (3) establishment of linkage between information policy and decision-markers of educational units.

7.Others

Various concerns could be summarized as follows: (1) the inclusion of computer courses to regular education programs, (2) the promotion of the level of information center in administrative hierarchy, (3) the allocation of budget to purchasing required equipment, and (3) the monitoring on the performance of the extended TANet program.

6.2 Major Findings From Questionare Survey

The major findings from the follow-up questionaire survey are summarized by question. Of them, thirteen questions with their survey results are thought interesting and are presented in the section. The chosen questions are:

1. equipment availability
2. availability of local area network for administration
3. availability of local area network for education
4. availability of leased circuits for telecommunication
5. funding for promoting computer education
6. required equipment when chosen as an experimental educational unit
7. interested CAI software
8. willingness to participate in CAI software development
9. degree of emphasis in computer education of the principle administrator
10. prefered time period for a long-session training program by teachers
11. prefered time period for a short-session training program by teachers
12. in a training program, courses that are prefered by teachers

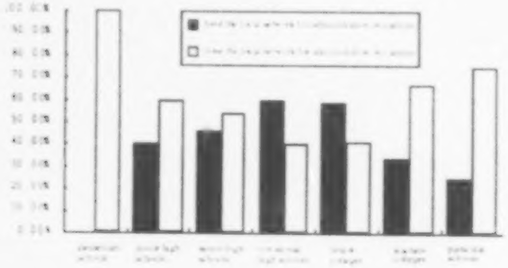
* Equipment Availability

	Available (%)	None (%)
Total	96.80	3.20

	Available (%)	None (%)
elementary schools	91.53	8.47
junior high schools	98.08	1.92
senior high schools	100.00	0.00
vocational high schools	97.92	2.08
junior colleges	100.00	0.00
teachers colleges	100.00	0.00
particular schools	100.00	0.00

* Availability of Local Area Netwrok for Administration

	Available (%)	None (%)
Total	37.71	62.29
elementary schools	0.00	100.00
junior high schools	40.00	60.00
senior high schools	45.71	54.29
vocational high schools	**60.00**	40.00
junior colleges	**59.09**	40.91
teachers colleges	33.33	66.67
particular schools	25.00	75.00



* Availability of Local Area Network for Education

	Available (%)	None (%)
total	25.00	75.00
elementary schools	7.41	92.59
junior high schools	6.25	93.75
senior high schools	35.29	64.71
vocational high schools	37.21	62.79
junior colleges	36.36	63.64
teachers colleges	40.00	60.00
particular schools	25.00	75.00

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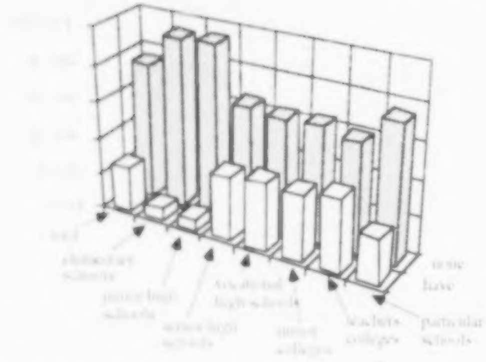


* Availability of Leased Circuits for Telecommunication

	Available (%)	None (%)
Total	16.45	83.55
elementary schools	7.27	92.73
junior high schools	2.08	97.92
senior high schools	9.09	90.91
vocational high schools	20.93	79.07
junior colleges	36.36	63.64
teachers colleges	**80.00**	20.00
particular schools	25.00	75.00

Finding:

1. Computer equipment for instructors in universities or colleges require being improved.
2. Vocational high schools and junior colleges are good selection of experimental educational units because they have comparatively more computer facilities.

* Funding for Promoting Computer Education

	Availability(%)
total	35.80%
elementary schools	7.69%
junior high schools	15.79%
senior high schools	**60.87%**
vocational high schools	**68.00%**
junior colleges	40.00%
teachers colleges	40.00%
particular schools	50.00%

Finding:

1. The senior high schools and vocational high schools have comparatively more funding for computer education.
2. Most private junior colleges are short of funding for computer education.

* Required Equipment When Chosen as An Experimental Educational Unit.

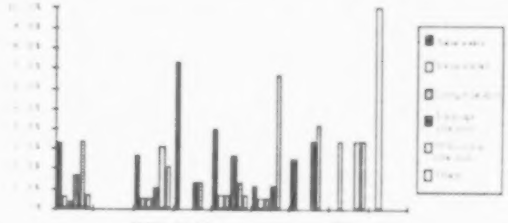
Purchased new computer	got new teachers of computer technic, or had teachers trained in computer	constructed network for education	constructed network for administration	had leased circuit to connect experimental units	others
4.00%	**13.50%**	3.60%	4.80%	6.30%	67.9%

Finding:

1. Most respondents of the schools select the answer "get new teachers of computer technic, or have teachers trained in computer" because they need special computer teacher.

* Interesting CAI softwares

	Natural science	Social science	[illegible] education	Language education	Professional education	Others
total	12.83 %	[illegible]	[illegible]	[illegible]	33.74%	[illegible]
elementary schools	26.32 %	5.26%	5.26%	10.53%	**31.58%**	21.05%
junior high schools	**73.33 %**	0.00%	0.00%	13.33%	13.33%	0.00%
senior high schools	**40.00 %**	6.67%	6.67%	26.67%	13.33%	6.67%
vocational high schools	11.11 %	5.56%	5.56%	11.11%	**66.67%**	0.00%
junior colleges	25.00 %	0.00%	0.00%	33.33%	**41.67%**	0.00%
teachers colleges	0.00%	**33.33 %**	0.00%	0.00%	**33.33%**	**33.33 %**
particular schools	0.00%	100.00 %	0.00%	0.00%	0.00%	0.00%



Finding:

1. The high schools prefer CAI of natural science.
2. The vocational high schools and junior colleges prefer the CAIs of frofessional education.
3. The teacher colleges prefer social scinece and professional education for CAIs.

* Willingness to Participate in CAI Software Development

	unwilling	willing
total	61.11%	38.89%
elementary schools	**58.49%**	41.51%
junior high schools	**65.96%**	34.04%
senior high schools	**63.89%**	36.11%
vocational high schools	**63.64%**	36.36%
junior colleges	50.00%	50.00%
teachers colleges	40.00%	**60.00%**
particular schools	100.00%	0.00%

Finding:

1. Most elementary schools, high schools, and vocational high schools are not insterested in participating in CAI software development.
2. Maybe it is because they do not have qualified teachers for computer education or they do not have sufficient fund to support.

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* Degree of Emphasis in Computer Education of the Principal Administrator

	extremely emphasize	more emphasize	middle emphasize	overlook
elementary schools	42.00	45.76	8.47	0.00
junior high schools	46.15	38.46	11.54	0.00
senior high schools	44.74	50.00	5.26	0.00
vocational high schools	56.25	35.42	6.25	2.08
junior colleges	45.45	40.91	9.09	0.00
teachers colleges	60.00	40.00	0.00	0.00
particular schools	75.00	0.00	0.00	0.00

* Prefered Time Period for A Long-Session Training Program by teacher

	Christmas holiday	Summer vacation	period of semester
elementary schools	16.95	**64.41**	52.54
junior high schools	26.92	**73.08**	63.64
senior high schools	43.24	**81.08**	45.95
vocational high schools	36.17	**82.95**	44.68
junior colleges	**59.09**	**85.17**	13.64
teachers colleges	40.00	**80.00**	50.00
particular schools	25.00	50.00	100.00

* Prefered Time Period for A Short-Session Training Program by teacher

	Christmas holiday	Summer vacation
elementary schools	35.09	47.37
junior high schools	34.62	53.85
senior high schools	52.63	**63.16**
vocational high schools	45.83	**66.67**
junior colleges	63.64	**76.19**
teachers colleges	40.00	60.00
particular schools	0.00	25.00

Finding:

1. Most teachers prefer joining long-session training program in summer vacation, but some in junior colleges prefer in christmas holiday.
2. Most teachers prefer joining short-session training program during semester.
3. The teachers in junior colleges rather prefer training in summer vacation than others.

* In A Training Program, Courses That Are Prefered By Teachers

	Program language	Spreadsheet	Operation system	Data base
elementary schools	45.76	57.63	54.24	**71.19**
junior high schools	50.00	53.85	51.92	**65.38**
senior high schools	48.65	45.95	45.95	**70.27**
vocational high schools	42.55	46.81	42.55	55.32
junior colleges	9.09	13.64	27.27	13.64
teachers colleges	30.00	40.00	50.00	40.00
particular schools	25.00	75.00	75.00	75.00

	Communication network	The concept of [illegible]	[illegible] hardware	The typing of Chinese
elementary schools	54.24	54.24	52.54	**64.41**
junior high schools	59.62	34.62	**63.46**	46.15
senior high schools	**81.08**	21.62	59.46	32.43
vocational high schools	**89.36**	19.15	**76.60**	21.28
junior colleges	**90.91**	9.09	**86.36**	13.64
teachers colleges	**80.00**	30.00	**60.00**	30.00
particular schools	50.00	25.00	75.00	50.00

Finding:

1. The teachers in elementary schools and junior high schools perfer database courses.
2. The teachers in senior high schools, junior colleges, colleges and universities perfer communication network courses perhaps it is because some of them are implementing local networks.
3. The teachers in all educational units need to maintain hardwares themselves because of poor services from computer vendors.
4. Strategic information planning methodologies are popular in vocational high schools, junior colleges, and normal colleges. The reason is that these educational units have computer equipment already and have difficulty in management and planning.
5. The need of computer languages, spreadsheet, O.S., D.B. and BCC are lower than 30% in junior colleges. Perhaps it is because that they have instuctors specialized in these fields.

7. Conclusion and Recommendation

Careful investigation of the study suggests solid conclusions on the expansion of TANet to various educational levels. Lower costs and cost-effective implementation strategies are searched and presented. Besides, educational training programs and selection of experimental educatinoal units are summarized. Nine points are also brought out for recommendation to future investigation.

7.1 Implementation Strategies

Implementation strategies could be grouped into short-, mid-, long-term strategies as discussed below respectively.

* Short-term Strategies
  - Allocate special funds to accelerate technology academies connecting to regional TANet centers and establish district network service centers in the near future.
  - Proliferate local area network in district network service center to expedite resource sharing among educational units.
  - Recommand serior high schools, vocation high schools, junior high schools and elementary schools using modem dial-up to connect to regional TANet centers to stimulate user requirements.
  - Personnel for maintenance and consultation in district network service center could be trained and hired by regional TANet centers.
  - Budget allocation to regional TANet centers for maintenance and extended network application could be based on utilization rate.

* Mid-term Strategies
  - Encourage senior high schools, vocational high schools, junior high schools, and elementary schools using modem dial-up to connect to district network service centers. However, if there exists requirement for leased circuits, it must be evaluated by the district network service center and report to MOE.

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- Supported by regional TANet centers, a district network service center could provide some training courses.
- Budget could be allocated to district network service centers for maintenance and extended network application based on utilization rate.

* Long-term Strategies
  - Encourage high schools,and elementary schools using leased circuits to connect to district network service centers.
  - Give both regular and irregular meetings for network application to increase professional prophiciency.
  - The long-term structure of the entended TANet could be exhibited as Figure 4.

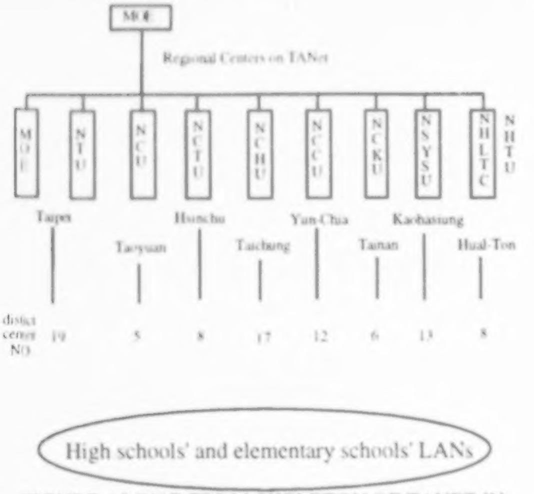

FIGURE 4 LONG-TERM SKELETON OF TANET IN THE FUTURE

7.2 Educational Training Programs

It is recommanded that a regional TANet center provide both short-term and long-term training programs. Regarding training cousrses, network concept and hardware maintenance are on the top priority. The teachers in senior high schools prefer database system and data communication in their listings of training courses; on the other hand, the teachers in junior high schools prefer database system and hardware maintenance, while the teachers in elementary schools prefer database system and chinese typing.

7.3 Selection of Experimental Educational Units

Following criteria are used to choose experimental educational units for extended TANet program.

1. the educational unit must have strong expectation to join the extended TANet program.
2. various characteristic educational units must have the opportunity to be chosen.
3. equipment and budget should be allocated to the chosen educational units based on their current faculty, equipment and training experience.
4. all of training schools and normal colleges should be deeply involved in the program.

Based on the aforementioned four criteria, tree alternatives are considered.

Alternative 1 : Uniform Selection From Shires(Counties) and Cities

1. Average allocating the testing schools in every shire and city, and try our best to developing District Network Service Center.Then we will the problems between regional centers and District Network Service Centers.
2. When District Network Service Center developed maturity, then we will expand the network connections step by step.

Alternative 2 : Selection of Key Shires(Counties) and Cities

1. Select some schools and their accordinate District Network Service Centers at key shires and cities, then try to developing their campus LAN and connecting between them.
2. When the key shires' and cities' network work maturity, then we will expand the District Network Service Centers and District Network Service Center's branches.

Alternative 3 : Selection of Single Shire(County) or City

1. Construct all the District Network Service Centers and connect to majority of schools in only one shire or city, and try to making a skeleton of network construction standard.
2. When the key shire's network developed maturity, then apply the model to other shires and cities step by step.

7.4 Recommendation for Future Investigation

With such a huge progarm on telecommunication network for education, awareness of following issues may give a smoother way for success.

1. How to allocate IP address to schools ?
2. How to create databases appropriate for high school and elementary school ? For example, sharewares or CAIs, quiz, personnel resources, and so on.
3. How to encourage training schools and Normal universities to aggressively participate?
4. How to organize teachers' group to support short-session training course in an area ?
5. How to introduce vendors to support maintenance and training courses for district network service center?
6. How to compile technical handbooks, management reference books, and user menus for TANet, for network building, training courses, and seminars in the future ?
7. How to recruit qualified instructors for information education?
8. How to build some typical network models for high schools or elementary schools to select?
9. How to modify the current computer courses to be associated environment in the future?

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SATELLITE WORKSHOP EXPERIMENT USING ETS-V

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1. Abstract

The international Satellite Workshop (SAWS) experiments are carried out using ETS-V satellite with 5 to 9 stations among 3 to 6 countries including NIME, CRL in Japan, KMITL in Thailand, ITB in Indonesia, etc. SAWS is held twice a month and 20 SAWS' are scheduled for 1993. It is useful for the study of the international scientific exchange system and also for the increase of mutual understanding.

2. Introduction

Satellite communication is effectively applied to the distance education or scientific exchange using its wide coverage capability. Open universities or schools using satellite systems are being run in the States, etc. Educational satellite communication experiments are conducted in Europe, Australia and Asia.

The educational or scientific exchange will be advanced further by introducing the international satellite communication system. However, the international satellite system has been used restrictively in this field due to the cost, or the difficulty to access the network, etc. And the effects or the problems of the international education or scientific exchange system among universities or laboratories are left for further studies.

Japanese Engineering Test Satellite V (ETS-V) for the mobile satellite communication experiments was launched in 1987. ETS-V made this type of international communication experiments possible with small earth stations. Simple and low-cost earth stations were developed and installed in the universities, laboratories, etc. in Japan, Thailand, Indonesia, Papua New Guinea, Fiji and Hawaii.

This article deals with the satellite workshop (SAWS) experiment which was started using ETS-V in January 1993 by National Institute of Multimedia Education (NIME), Communications Research Laboratory (CRL) in Japan, King Mongkut's Institute of Technology Ladkrabang (KMITL) in Thailand, Institute of Technology Bandung in Indonesia, in cooperation with other institutes.

3. ETS-V experiments and ISY

ETS-V was launched by H-1 rocket in 1987 from Tanegashima Space Center in National Space Development Agency of Japan (NASDA). The transponders on board were developed for the mobile satellite communication experiments. L-band (1.6/1.5 GHz) and C-band (6/5 GHz) frequency are used for the mobile link and the feeder link respectively. The L-band antenna is the first multi-beam antenna in Japanese satellites. L-band antenna coverage is shown in Fig. 1. Two antenna beams are called as North beam (N-beam) and South beam (S-beam) which cover North Pacific Ocean and Southeast Asia respectively.

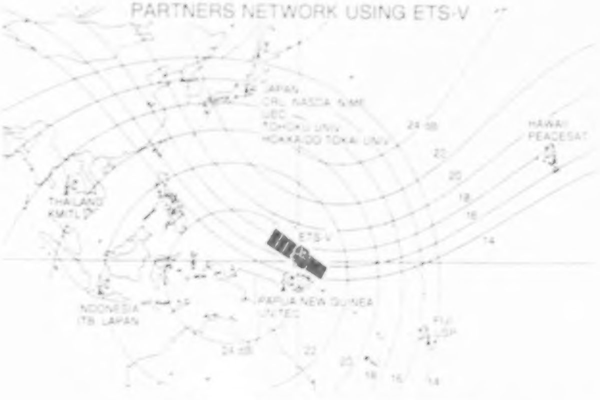

Fig. 1 ETS-V Antenna Coverage

Various types of mobile satellite communication experiments have been carried out by CRL, etc. The study of the satellite communication system for mobile stations came to include the video signal transmission for the mobiles and the video exchange among small earth stations. The Pan-Pacific information network experiments began between CRL and University of Hawaii using ETS-V in 1990, and a TV conference experiment was successfully carried out in Nov. 1990 using simple earth stations developed by CRL. This system enabled to communicate with digital motion video signal through 64 kbps satellite channel. This technology is important for the improvement of the information network especially for island countries in the Pacific area.

On the other hand, the year 1992 was proposed to be ISY (international space year) by Senator S. Matsunaga in United States, because it was 35 years after the launch of Sputnik and 500 years after America was known to the Europe. The satellite communication experiment "PEACESAT expansion / Pan- Pacific Information Network" which was proposed by CRL and University of Hawaii was selected as one of the ISY activities in the field of communication. This activity was expanded to be "PARTNERS Project" mainly by Japanese Ministry of Posts and Telecommunications (MPT) and NASDA in cooperation with universities in Japan, Thailand, Indonesia, Papua New Guinea, Fiji and Hawaii.

University of Electro-Communications, Tohoku University and Hokkaido Tokai University have made their earth stations for themselves with the support of CRL. The improved earth stations which have the same function were manufactured under Japanese MPT and NASDA and installed in NIME, CRL (Kashima), NASDA, Thailand, Indonesia, Papua New Guinea and Fiji.

4. Satellite Workshop Experiment (SAWS)

4.1 Objectives of Satellite Workshop

The first international satellite workshop (SAWS) experiment was held by NIME, CRL, KMITL and ITB in 1993 January. The objectives of SAWS activity are shown in Table 1.

Table 1 Objectives of SAWS experiment

Exchange scientific and technical information
Increase mutual understanding
Study the optimum use of the compressed video system
Improve the operation techniques for the satellite system with simple earth stations
Clarify and study the problems for the international scientific exchange network
Study multiple access techniques for simple earth stations

SAWS is held twice a month in general. The University of Electro-Communication in Japan, The Papua New Guinea University of Technology, University of South Pacific in Fiji, PEACESAT in University of Hawaii and NASDA also participated in SAWS from June or July 1993.

4.2 Experimental System

The experimental system is composed of small earth stations, the ETS-V satellite and a hub station as is shown in Fig. 2. This system is designed to exchange TV conference signal with the compressed video moving picture by using small, simple and portable earth stations.

The transponder configuration of ETS-V can be select L-band loop back mode or C-band feeder link mode. When L-band loop back mode is selected, any two stations in the same L-band coverage can communicate each other, with point to point communication basis. However, L-band loop back mode can not support the cross connection between N-beam and S-beam coverage.

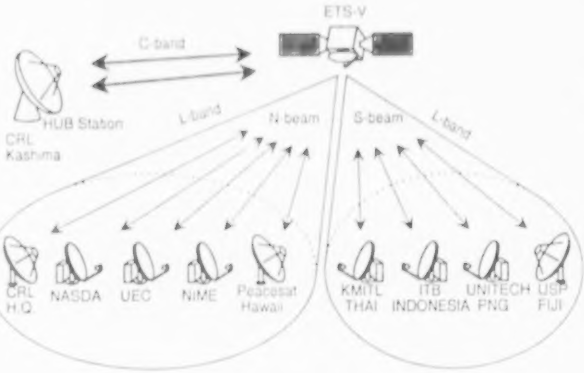

Fig. 2 System Configuration of SAWS Experiment

When the C-band feeder link mode is selected, Each L-band beam is connected to C-band feeder link through ETS-V transponders. Therefore, interconnection between N-beam and S-beam coverage can be supported through the hub station. In case of point to multi-points communication, it is necessary to have a hub station which broadcast the combined signal from two stations for all other stations to be able to hear their discussion. The CRL Kashima station works as a hub station, as well as a participant station.

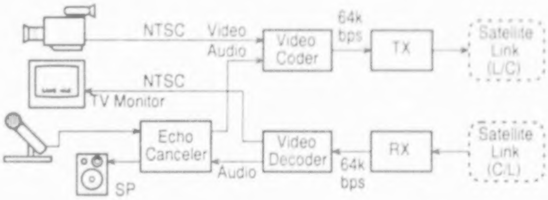

Fig. 3 Configuration of Small Earth Station

The configuration of the small earth station is shown in Fig. 3. TX and RX unit of the earth station are consist of dish antenna, outdoor unit which contains a high power amplifier for transmission, low noise amplifier for reception and a diplexer and indoor unit which contains transmitter and receiver. Base-band system consists of a video codec, which include a video coder and decoder, echo canceler and studio equipment including the audio and video systems.

The antenna diameter used for the small earth stations is 1.2 m diameter except for Hawaii and Fiji station. 3 m and 3.6

m dish antennas are required to receive ETS-V signal in Hawaii and Fiji respectively, because these station are positioned at the edge of the ETS-V coverage. For example, the link budget for Thailand station is shown in Table 2.

Table 2 Link Budget (C to L and L to C link)

TX station	Japan	Thailand	
RX station	Thailand	Japan	
TX Power	10.0	10.0	dBW
TX EIRP	61.2	31.0	dBW
Propagation Loss	199.6	188.6	dB
Satellite G/T	-8.2	-11.3	dBK
Up-link C/No	82.0	59.4	dBHz
Satellite TX Power	4.9	-17.7	dBW
Satellite TX EIRP	21.7	1.5	dBW
Propagation Loss	188.0	198.4	dB
Earth station G/T	-0.6	32.7	dBK
Down-link C/No	61.7	64.3	dBHz
Total Link C/No	61.6	58.2	dBHz
Required C/No	55.5	55.5	dBHz
Link Margin	6.1	2.7	dB

Table 3 Main Parameters of Small Earth Station

TX Frequency	1644.5 - 1647.225 MHz
RX Frequency	1542.5 - 1545.225 MHz
Antenna	1.2 m diameter Offset Parabolic
HPA	5 W (typ.) Linear Amplifier
Modem	Data Link: 128 kbps QPSK
	Voice Link: Narrow band FM
FEC Coding	Convolutional Coding (R=1/2, K=7)
FEC Decoding	Viterbi algorism (4bit Soft Decision)
Data Rare	64 kbps (TV Conference mode)
Multiplexed Data	16 kbps Voice data: 2ch
	9.6 kbps FAX Data: 1ch
	4.8 kbps PC Data : 2ch
Picture Coding	46.4 kbps ITU-T(CCITT) H.261
Picture frame rate	15 frame / sec (Max)
Picture resolution	CIF: 352 pixels * 288 lines
	QCIF: 176 pixels * 144 lines
Voice Coding	16 kbps APC-AB coding

The main specifications of small earth station are shown in Table 2. The compressed video signal is transmitted through 128 kbps QPSK digital channel. According to the Error correction coding, the information bit rate is reduced to 64 kbps. The picture coding scheme follows H.261 ITU-T (CCITT) standard. For the voice coding, adaptive delta modulation is employed. The 16 kbps APC-AB digital coded voice is included in this 64 kbps.

64 kbps data rate is selected, because;

- it keeps the simplicity of an earth station with as small antenna as possible,
- it provides the minimum video conference capability,
- the bandwidth of the L-band loop back link in ETS-V is limited to few channels at 64 kbps of data rate,
- it provides the possibility to use ISDN equipment or the future integration into the ISDN network.

64 kbps data can be divided into two 16 kbps voice, one 9.6 kbps and two 4.8 kbps data channels, by using the MUX/DEMUX module which make it possible to perform various types of experiment using personal computer, multimedia player, etc. FM voice channel is also available, and it is easy to used as an order wire link.

Total weight of the small earth station is less than 20 kg, and it is easily to pack and transport by using a van. Therefore, It makes the wide and simple distance education or scientific exchange possible via satellite. The compactness of the terminal is important also for the "field education" or "personal education". And the higher performance or functions of a small earth station might be achieved with the progress of the satellite communication technologies.

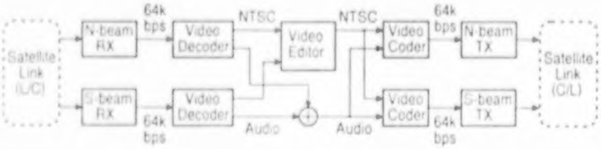

Fig. 4 Configuration of HUB Station

Fig. 4 shows the configuration of the hub station. Kashima Space Research Center of CRL works as a main earth station of the ETS-V experiment. 10 m dish antenna is used for C-band feeder link. Two set of the 64 kbps modem are prepared for the hub station. In case of the point to multi-point mode, received signals from N and S-beam are demodulated and decoded to NTSC video and audio signals. Then, Video signals are combined to by using a video editor with picture in picture basis. Combined signal is transmitted to all small stations through C-band to L-band satellite link.

4.3 Configurations of Satellite Link

Two types of switching mode as shown in Fig. 5a, 5b were used. These are two channels mode and multiple channels mode.

(1) Two channels for discussion (Fig. 5a):
Two fixed channels are prepared to collect the signals from small earth stations to the hub station. Two stations are transmit and receive to have a discussion. The others stand by the transmission and receive the signal from the hub station. One station in the two gives the post for transmission to another station by stopping his transmission.

(2) Multiple channels and selection (Fig. 5b):
Every small station is assigned different channel. Two of the channels are selected in the hub station to compose a broadcast signal.

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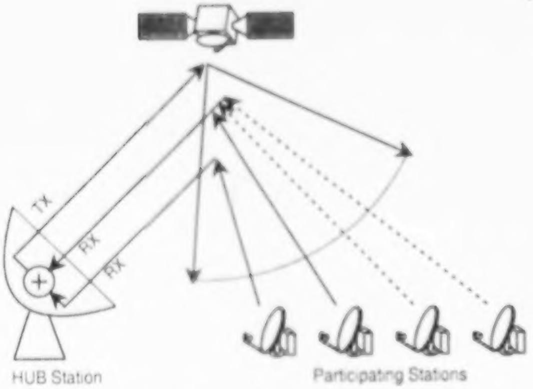

Fig. 5a Two Channels Mode of Satellite Link

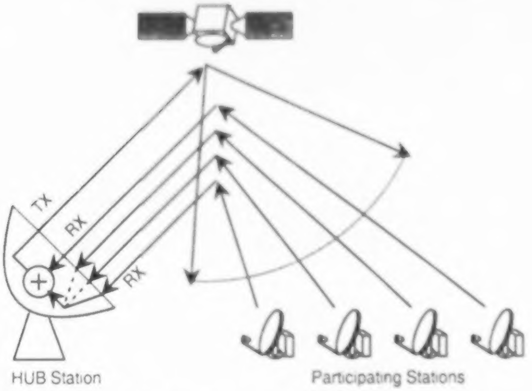

Fig. 5b Multiple Channels Mode of Satellite Link

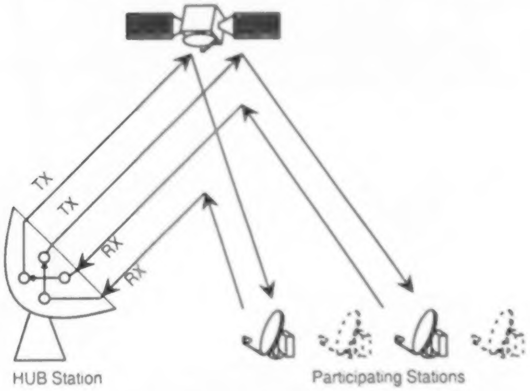

Fig. 5c Cross Link Mode of Satellite Link

In the latter case, CRL Kashima station functions as an intelligent hub station, which select the channels following the discussion. It was more effective than the former case for the discussion among multiple stations, however more channels are required.

Fig. 5c shows the cross link mode. This mode can be use for the point to point communication with two stations.

These simple double-hop configurations bring about the following problems;

- the degradation of the picture quality due to the decoding, mixing and coding process in the hub station,
- the absolute echo (about 0.5 seconds delayed) due to the retransmission by the hub station.

4.4 Satellite Workshop Experiment

A series of Satellite Workshop (SAWS) experiment was started in January 1993 and it held almost twice a month. 20 SAWS experiments are scheduled until December 1993.

Each SAWS is about 90 minutes period, in which one or two topics are presented by researchers or by invited experts. The participants are researchers, related researchers and students. The questions and answers or discussion are held after the presentation. The typical numbers of the participants are three to ten in each station. Small group discussion gives free and frank atmosphere among the participants.

The topics for SAWS program are listed in Table 4.

Table 4 Themes of SAWS Experiments

Satellite Communication	ETS-V, ETS-VI system, PARAPA system, Thaicom system, Future communication satellite, Space development
Telecommunication	SAWS System, Antenna development
Data Communication	Computer network, Packet data communication
Signal Processing	Picture coding techniques, Remote sensing
Satcom Experiment	Picture quality evaluation, L-band propagation experiment
Distance Education	Japanese language education
Cultural Exchange	History of each country, Culture
Others	SAWS program, Maintenance

The "cultural exchanges" are included in SAWS program to strengthen the mutual understanding among the participants.

The workshop program about the technology is important, because;

- the earth stations are operated by researchers themselves in the telecommunications field.
- English is used at the discussion, and it is a foreign language in many members. The discussion will be easier if common technical terms are used.

- it is useful for researchers to exchange the latest technical activities or information.

The presentation techniques and the camera work, such as the drawing using large characters, appropriate zooming and minimizing the panning time of the camera, for example, are important to make the best use of the 64 kbps compressed video picture. The additional camera dedicated to show the drawing or still pictures is one of the powerful tools. The summary or related document sent in advance with SAWS by FAX are used to assist the effective discussion. The application of a still picture transmission system or computer graphics using data link requires further examination.

5. Improvement of SAWS System

The results of SAWS experiments show that some technical issues should be improved. These are listed as follows.

5.1 Multiple access techniques

Hub station can receive two channel of compressed video signal. However, the hub station can not get the information from other station which stand by the transmission. Therefore, it is better to prepare the voice channels from other station through the satellite. Then, Channel assignment and link control can be done easily.

5.2 Improvement of Picture Quality

The subjective evaluation of the picture quality changes the resolution and the refresh rate of the picture frame. The data rate is limited to 64 kbps. Then, higher refresh rate gives low resolution of the picture. And higher resolution gives slower refresh of the moving picture. The set of the refresh rate and resolution should be optimized for the different types of the picture such as TV conference, still picture computer graphics, movie, etc.

Another disadvantage of the picture quality of SAWS system comes from double hop communication. Picture decoding and coding at the hub station degrade the resolution. In order to remove this process at the hub station, 64 kbps digital data interface with frame memory is discussed. Fig. 6 shows the configuration of the hub station with frame buffer interface.

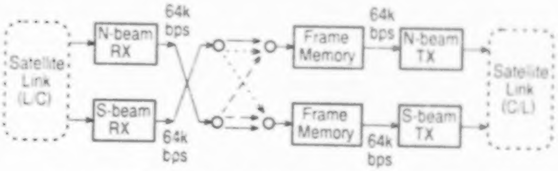

Fig. 6 HUB station with Frame Buffer Memory

By using the frame buffer memory received data can be feed to transmitter. However, This system operate as a cross link mode, and can not edit the pictures from two stations. Therefore different configuration of the satellite link is prepared. Fig. 7 shows satellite link for this mode.

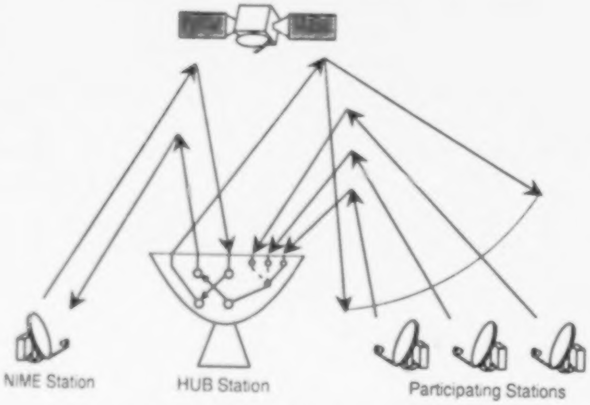

Fig. 7 Multiple Link Mode for Digital interface

In this configuration, picture in picture can be done at NIME station as a chair station. The configuration of the chair earth station is shown in Fig. 8.

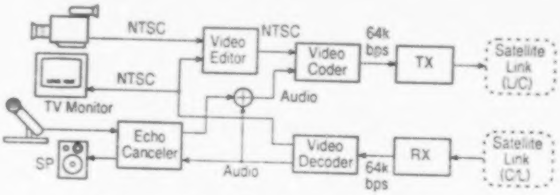

Fig. 8 Configuration of Chair Earth Station

In the Chair earth station, received picture and picture from studio are combined and transmitted. Then, the picture of a chairman or speaker has no degradation. received picture is decoded and reduced it's size and coded. However, there is few degradation of the picture quality, because received picture size is reduced.

5.3 Improvement of Audio Quality

Main factor which degrade audio quality is the echo generated from the satellite link. In this system, all stations have echo canceler. Normal echo canceler cancels reflected audio sound signal, which comes from the speaker system connected to the receiver, at the microphone input. In case of point to multi-point communication, voice signal from one small station is broadcasted from hub station. Therefore, that station receives loop back voice signal. This loop back voice echo is generated at the hub station. In order to solve this problem, the special echo canceler which can cancel the echo with satellite double hop delay is needed.

Fig. 9 shows the configuration of the normal echo canceler.

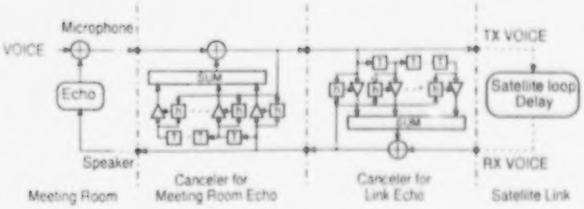
Microphone
VOICE
Echo
SUM
Speaker
TX VOICE
Satellite loop Delay
RX VOICE
Meeting Room
Canceler for Meeting Room Echo
Canceler for Link Echo
Satellite Link

Fig. 9 Principle of Echo Canceler

In Fig. 9, canceler unit for room echo can cancel audio echo with up to 30 ms of delay. Canceler unit for link echo also have the same performance. However, double hop satellite link delay is bigger than 0.5 second. Therefore, this link echo canceler does not work for satellite delay.

Double hop delay echo generated by SAWS system has simple echo profile. Therefore, link echo canceler can be designed with simple delay circuit. Fig. 10a, 10b shows the block diagram of the echo canceler for SAWS system.

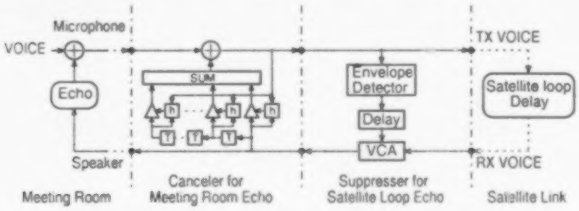
Microphone
VOICE
Echo
SUM
Speaker
Envelope Detector
Delay
VCA
TX VOICE
Satellite loop Delay
RX VOICE
Meeting Room
Canceler for Meeting Room Echo
Suppresser for Satellite Loop Echo
Satellite Link

Fig. 10a Echo Canceler with Delay Echo Suppresser

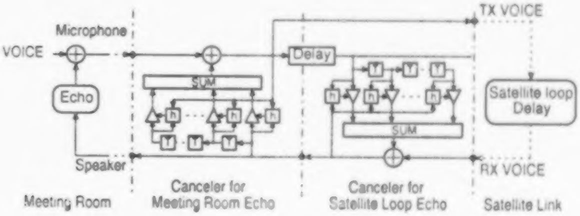
TX VOICE
Microphone
VOICE
Delay
Echo
SUM
SUM
Satellite loop Delay
Speaker
RX VOICE
Meeting Room
Canceler for Meeting Room Echo
Canceler for Satellite Loop Echo
Satellite Link

Fig. 10b Delay Echo Canceler

In Fig. 10a, double hop echo is reduced using receiver volume control according to the transmitted voice level. This type can be simply implemented. However, it is not best for interactive discussion. In Fig. 10b, delayed voice signal is prepared for satellite loop echo canceler. This delay time should be carefully tuned to adjust satellite double hop delay. This echo canceler system will work well for SAWS system.

5.4 Improvement using Side Information

The highly compressed video system will be effectively applied if there are another information about the members. Side information are given by;

(1) Brain memory

For example, both participants have the common image of the object, or participants know each other.

(2) Common materials or files

For example, materials, printed or in other media are distributed in advance.

(3) Free questions and answers

In this case, the picture is supplementary. For example, discussion or questions and answers are important than the quality of the picture.

6. Conclusions

SAWS activity is considered to be one of the suitable application of the compressed video system because the number of the members is limited and all members know each other.

The features of this SAWS activity are summarized as follows;

- almost all earth stations are operated by researchers:
  It facilitates to extract technical or operational problems to be solved.
- technical workshop:
  It is useful for the researchers who are operating the earth station for themselves, and the communication becomes easier thanks to the common technical terms although English may be a foreign language to the researchers.
- international workshop among multiple countries:
  The time difference limits the hours of the activity but it is useful for the mutual understanding.
- multiple stations are participating:
  Operating satellite workshops by 5 to 9 stations together, the study of multiple access techniques can be stimulated.

There is no national boundary on the scientific research. Various types of scientific exchange have been performed. A wide coverage and low cost network is required to expand these activities.

The SAWS activity which uses 64 kbps compressed video among several countries in the Pacific region can be a model of international scientific exchange network with simple and low-cost earth terminals. However, the system used in SAWS requires further improvement to grade up to be a wide, general and effective system. It is effective enough for researchers for information exchange or mutual understanding.

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OPENet: A Collaborative Learning Environment for Education and Training

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ABSTRACT
This paper introduces the design and the implementation process of OPENet, a new online service of the Open Learning Agency that includes computer conferencing, email, and Internet access. OPENet's instructional models for course delivery will also be introduced and current programs described. The paper concludes with a discussion of future directions for OPENet.

1. Introduction

Since the first computer conferencing system was designed and implemented in 1973 (Turoff, 1990) this tool has been adopted to support and enhance human communication for decision-making, training, access to information, and education.

Computer conferencing has been adopted by corporations and government agencies as a way to facilitate access to information and to enhance organizational communication. In the 1980's computer conferencing was introduced in higher education to deliver online courses (Harasim, 1990; Hiltz, 1990). Primary and secondary schools have also begun to use this technology to support learning networks and information sharing (Levin, 1990; Riel, 1990; Teles, 1993). Combined with other tools, computer conferencing can be a valuable application to support teaching and learning.

1.1 The Open Learning Agency

The Open Learning Agency (OLA) is an institution that promotes open access to learning opportunities in a variety of delivery formats. The Agency has introduced computer conferencing as a technology for course delivery, training, information access and sharing.

The introduction of a computer conferencing system is also part of a broader strategic vision of a "networked OLA" and the Agency's role in providing provincial leadership in the instructional and training-based areas through new media.

2. OPENet: A Collaborative Learning Environment

OPENet is an integrated service that offers computer conferencing, email, and Internet access. A collaborative learning model is used to facilitate information-sharing and group work among peers, under the guidance of the tutor.

OPENet users become members of a community of learners where they find support via the interaction with peers, experts, and access to learning resources. Through OPENet the Agency offers a variety of services to learners at home and trainees in the workplace.

2.1 Technical Specifications

OPENet runs on Participate and Convene software customized by the Open Learning Agency. Participate is the computer conferencing system and Convene is the off line reader connected to Participate. The two programs are housed on a VAX computer running Ultrix. End users can access the host computer via DOS and Apple computers. OPENet has LAN connectivity. The modem connection has 8 dial up lines. These lines support up to 19.200 BPS data transmission. OPENet also offers Internet connectivity.

A metaphor was used for the design of the software whereby the learner accesses an address book from where s/he selects the names, either of individuals or conferences (public and private). The user opens the address book which contains the names of other users and of OPENet conferences. Once s/he has selected the addresses and written the messages these are placed in the mailbox. The mail box handles incoming and outgoing messages. When the user activates the send/receive command the system uploads the messages to the host computer and downloads new messages. Three pages of text are uploaded or downloaded in 40 seconds at the 2,400 BPS baud rate.

OPENet supports file transfer through the ZModem protocol. Files can either be appended to conferences or to personal messages. Remote login through Telnet and File Transfer Protocol (FTP) are also available. The OLA Gopher provides access to British Columbia's Electronic Library Network. The learner can access online libraries of colleges and universities in the province. In addition, OPENet users can also access any other Internet site.

The user needs access to a computer, a modem, and a telephone line. Once this is in place, OPENet operates in the following way: the learner receives a diskette containing a copy of the OPENet account and software for either an IBM or an Apple computer. The diskette and the print material for course support is sent as regular mail through the post office. The user inserts the diskette in the computer and enters the information required. Once this step is completed the learner uses the join command to become a member of OPENet. The final step is the activation of the send/receive command to establish the connection with OPENet. The user will receive an welcome message containing information on how to navigate online.

2.2 Design

The design of the online environment is a key issue for the success of the learning process. Online instructors need to design the educational activities and learners need to know in detail what they are expected to do online (Harasim, 1990; Riel, 1990; Teles, 1993). Telecommunications access software should be simple and easy to use. Timeline considerations must be taken into account: short projects with well-defined end-points have been successful (Fredman, 1989).

The design of learning tasks in online environments and the pedagogy used in these new spaces are different from traditional face-to-face designs. The pedagogy is also different from that used in other distance education delivery modes. Computer conferencing facilitates peer interaction, interaction with tutors, and access to online resources. Thus, the pedagogy of online learning requires appropriate designs and moderating skills.

The asynchronous or non-real time nature of the interaction provides time for reflexion and research thus allowing learners to actively participate in the knowledge building process for collaborative learning environments. This collaborative model emphasizes group work and active exchange of interaction among participants.

The design of OPENet emphasizes asynchronous communication to facilitate structured human interaction for learning purposes. The design combines collaborative work with individual effort. A combination of individual work and continuous feedback fosters motivation and facilitates learning.

2.3 Configuration

OPENet has a root conference called Welcome. This is a read-only conference that provides information about OPENet policies and public conferences. Various subtopics for the Welcome conference provide informal areas for interaction: Open Media, Open Cafe (to introduce oneself and to exchange informal communication, chat, etc.;), All Conferences (a list of all conferences on the system); Technical Help (to provide help to beginners), and Netiquette (where users are given information on how to interact online).

The front end operates off line and provides a familiar and friendly interface to make users feel comfortable in the online environment without the constraints of "noisy" phone lines, cost of online time, and the need to learn new online editors and commands.

Figure 1: The OPENet Configuration

3. The Implementation Process

All OLA's departments were to provide input into the discussion about the use of computer conferencing at the Agency. The Instructional Computer Users Group (ICUG), comprised by representatives of all areas decided to create four discussion groups to develop policy recommendations: Online etiquette and security, Training and ongoing support, Access and charges, and Evaluation. Once these recommendations were produced and submitted to OLA's Executive, the implementation process was initiated.

The implementation process of OPENet is comprised of four steps:
1. selection of a computer conferencing system for course delivery,
2. installation and testing, 3. training, 4. delivery of programs.

The selection of an appropriate system for course delivery was conducted through a discussion process in the ICUG working groups. Eight criteria were put forward to select a system:

- The system should have a front end that operates off-line, with the option to go online if needed (for real-time communication).

- The system should have Local Area Networks (LAN) connectivity and access to Wide Area Networks (WAN) via Internet with synchronous and asynchronous communication options.

- The system should communicate with most platforms, particularly DOS and Apple.

- E-mail, conferencing, and other online resources to be chosen by the end-user should be integrated into a single "online inbox"; e-mail messages should be easily placed in conferences and conference messages easily made into e-mail messages.

- The system should support FTP (File Transfer Protocol) and provide easy commands for file transfer and Telnet, to acess other online services.

- The system should be easily customized by instructional designers and tutors for specific teaching purposes and should provide usage statistics.

- The system shoud also be used by other educational institutions.

Participate running through the Convene interface was selected. In addition to the Open Learning Agency, the University of Phoenix Online Program also uses the same software.

3.1 Installation and Testing

The installation and testing of the software took twice as long as predicted, due primarily to the fact that this was the first time an Ultrix platform was used. Participate and Convene also run on SCO and Interactive Unix platforms.

The installation has been concluded and the service is operational with an initial group of 30 users to test the system.

3.2 The training Program

Three manuals have been produced: User's Manual for Apple computers, User's Manual for DOS, Moderator's Guide. A training program has also been developed and the first group is to receive training in December, 1993.

4. Delivery

The first courses are to be delivered in March 1994. Other courses and an MBA program are currently being designed to be delivery in 1994/1995.

4. Instructional models

The following instructional models have been explored as potential formats for course delivery:

1. Access to information and peers,
2. Access to experts in particular content areas,
3. Tutor support in various formats,
4. Collaborative model.

In the "Access to information and peers" model the learner exchanges messages with peers to discuss course related issues. Learners can also access online libraries and resources. The tutor, however, does not participate in online activities.

In the "Access to experts" model, experts in particular content areas are available to respond to questions, to clarify issues, and to provide guidance. For example an online expert in Geography supports students taking Geography I, Geography II, Ecology I, and other courses in the same area.

The "Tutor support" model has a variety of formats. Some of these are:

- As students access OLA's tutors via telephone, those with computers can access tutors via computer conferencing to send assignments and to exchange messages. Tutors willing to use the computer to replace the phone would be given financial support to purchase a computer.

- Other tutors prefer to deliver some course sessions online and other sessions via print-based material.

- Tutors can also combine computer conferencing with other media such as video, audio conferencing, etc. to enhance learning opportunities.

The "Collaborative model" for course delivery is designed to provide active instances of group work and information-sharing. Students prepare class presentations and deliver their work to the virtual class. Students are also graded on their online assignments.

Evaluation

Evaluation of user-friendliness, quality support service, quality of computer supplier service, course evaluation, student satisfaction, and achievement of course objectives, will be conducted through surveys and analysis of online usage data. The system has an accounting software to provide usage information which also facilitates the collection of online data.

5. Current projects

Two projects have been set up in OPENet: a project to link coordinators of ABE programs in several colleges in British Columbia and a project to coordinate the activities of the Western Universities Telecourse Consortium.

In addition to these two projects the Agency will offer seven courses via computer conferencing beginning in March, 1994: a course on Nursing in collaboration with the British Columbia Institute of Technology (BCIT); Computers 109, Educ 4 (Teaching French), Geography 401 and 402, Business Administration, and International Business.

6. Conclusions

The approach used to introduce computer conferencing for course delivery and training is based on the theoretical foundations of collaboration, combined with individual work. The active participation of students with an ongoing interaction among peers and with the tutor are essential characteristics of this model for online learning.

As OPENet becomes an integral component for course delivery at the Open Learning Agency, students will increasingly benefit by the advantages of this new medium for course delivery and training.

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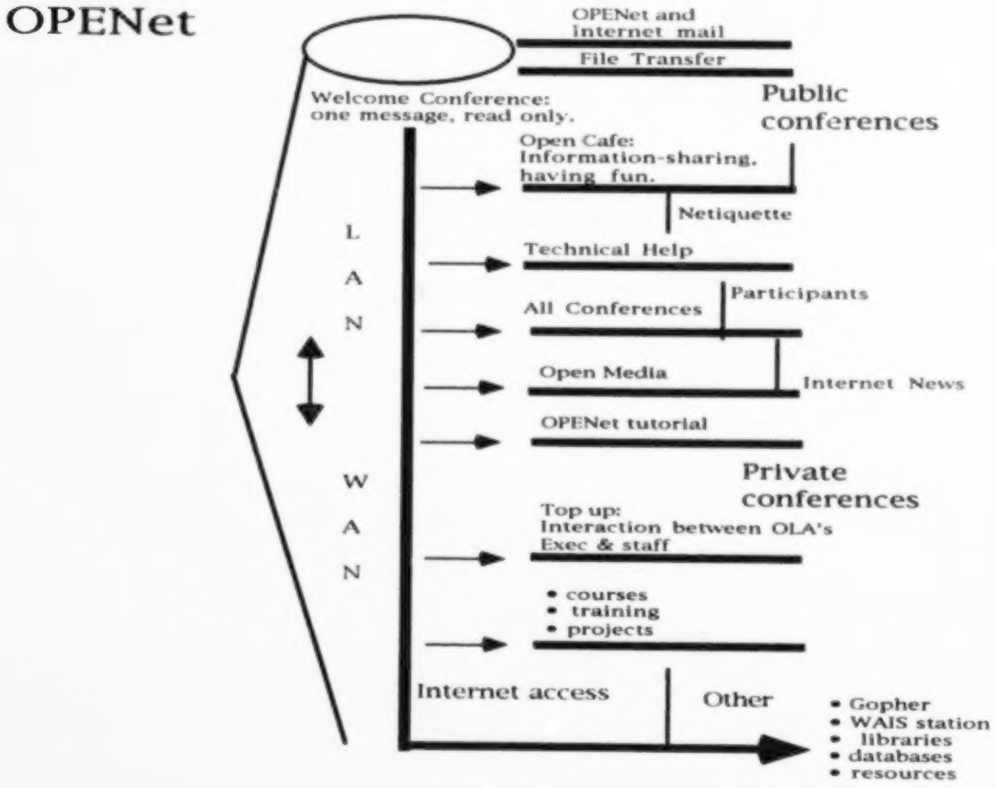
Figure 1: The OPENet Configuration


OPENet
OPENet and Internet mail
File Transfer
Welcome Conference: one message, read only.
Public conferences
Open Cafe: Information-sharing, having fun.
Netiquette
Technical Help
All Conferences
Participants
Open Media
Internet News
OPENet tutorial
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N
Private conferences
Top up: Interaction between OLA's Exec & staff
• courses
• training
• projects
Internet access
Other
• Gopher
• WAIS station
• libraries
• databases
• resources

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